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ABSTRACT

This document presents a transcript of the hearing on science, mathematics, and technology education in the public schools, held by the National Commission on Excellence in Education at Stanford University, March 11, 1982. National perspectives on the topic were given by representatives from the National Academy of Sciences, the Council of Scientific Society Presidents, the National Science Teachers Association, the National Council of Teachers of Mathematics, and a technical consultant from the Hewlett-Packard Company. Following the statements of these panelists, questions and comments were elicited from Commission members and other members of the panel. Opportunity was provided for statements from individual educators on problems and programs in science, mathematics, and technology in which they were currently involved. General testimony was received from members of the audience about existing programs that represent excellent examples of educational practices. (JD)

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PUBLIC HEARING

on

SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION

Tresidder Student Union
Room 281
Stanford University
Stanford, California

March 11, 1982
8:30 a.m.

SP 022 071

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CHARLES A. FOSTER, Jr.

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Voluntarily Submitted
Written Testimony
Public Hearing - Science, Mathematics and Technology Education

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PROCEEDINGS

(8:40 a.m.)

DR. KENNEDY: Good morning, everybody. I am Don Kennedy, President of Stanford. I want to welcome the members of the Commission, witnesses and auditors to this program on behalf of Stanford University.

Mike Atkin, the Dean of Stanford's school of education, and I are especially happy to act as hosts for the first national hearing of the National Commission on Excellence in Education.

As you know, the subject of this particular hearing will be dealing with Science, Mathematics and Technology Education, and that is a matter of particular interest to a number of people in this university and in this part of the world generally.

We have also come to a place in which concern for public education in general is alive and well. I want to assure you our own worries on this topic have led Mike and me to initiate a major effort here at Stanford on public education.

And I will risk sounding a little bit more like a witness than I should by taking a minute or two to tell you something of the genesis of that concern.

It occurred to both of us that it wasn't very difficult at Stanford to assemble 50 or 60 faculty members in a room to talk about health policies, none of whom were members of our medical school faculty. But to get even a third that number of faculty members outside the school of education to be concerned about the equally important matter of public education policy was much more difficult.

And we thought that it was high time not only to demonstrate our pride and faith in our own school of education and in its capacity to work productively on the problems of public education, but to make a significant institutional effort to get more faculty members from outside that school concerned about, troubled about working on the problems of public education.

That effort is just the beginning, but obviously it is helpful to us and to our own attention to that kind of problem to have this distinguished group of people visit and hold this hearing. And we are terribly glad you decided to do it.

I might say that one of the panels in the study Mike and I are setting up will be one on curriculum. And I suspect that a very important part of it will deal with science curriculum matters.

I have a modest set of credentials of my own in this area, which I won't bore you with, but it does produce a kind of occasion for reminiscence seeing people like Paul Hurd and Paul Cartlett with whom I have been associated briefly in the past in such matters.

It reminds me of the excitement that all of us who taught science in the universities felt about the science curriculum revision efforts of the late 50s and early 60s. It was an extraordinary time. A lot of us learned a great many things.

I can't give you a complete assessment of the lessons that I took away from the Biological Sciences Curriculum Study and the various travels to NFS summer institutes in trying to set up laboratories to demonstrate various things to extraordinarily eager and interested high school teachers.

But it was a really splendid experience from which I learned at least the following.

It is possible to involve wide and enthusiastic national participation in a venture like that if the challenge is right, and if even modest resources can be supplied to fuel the effort. And nothing can be more rewarding to the people who involve themselves in it.

And, finally, as a personal and rather limited lesson I drew from it, I discovered in my travels around the high schools in which I was shown what real teaching was like, that for a university professor, in order to establish a verisimilitude, it is not necessary to require them to teach eight consecutive periods of seventh grade general science.

Four will suffice.

I do want to conclude with one reflection about the importance of this venture. And I think I have learned it equally in the capacity of university professor and research scientist, head of a government regulatory agency and president of the university.

And it is that I firmly believe in the importance of scientific literacy, not merely as a tool that exceptional young people in our society bring to the task of innovation and to the task of improving on national productivity and to all the other national social goals to which we turn the scientific process.

But because general scientific literacy is critical to an understanding of the world -- and I mean to any understanding of the world -- and toward th[illegible]telligent and thoughtful support of public policies.

Because there is scarcely a major issue facing us today, whether it is a domestic or an international one, that doesn't have a scientific or technical component.

And we as a nation will experience dreadful difficulty in resolving these in a way that can win the support of our citizens if the level of scientific literacy is not improved over its present level.

So, what you are up to is terribly important. We are very glad that you are starting the undertaking here and glad to have you on board. And I will conclude this with the impertinent quote that when you are through, the folks who appointed you will still be there and that they will have some resources to put in place all the good ideas that I know you will generate.

Mr. Chairman, it is a pleasure to have you here. I welcome you.

DR. SEABORG: Thank you, President Kennedy.

My name is Glenn Seaborg and I am serving as chairman of this public hearing on Science, Mathematics and Technology Education which is being conducted under the auspices of the National Commission on Excellence in Education.

Let me begin by welcoming all of you here this morning, and by expressing my pleasure for the opportunity to open this first series of hearings of the National Commission on Excellence in Education.

I also want to thank President Kennedy and Dean Atkin for hosting this hearing at Stanford University. President Kennedy referred to his participation in the exciting days of curriculum improvement in the late 1950s and early 1960s.

I, too, participated in that, serving as chairman at that time of the Chemical Education Material Study, the Chem-Study program, which revised the chemistry curriculum for high school chemistry.

Now, just by way of background, I want to note that the Commission was established last August by the Secretary of Education, Terrel H. Bell, in response to the widespread public perception that the quality of American education has been undergoing a severe decline in the last two decades.

The Commission is charged with issuing a final report to the American public and to the Secretary by March of next year. Today's hearing on the quality of education in science, mathematics and technology is but the first of six hearings which the Commission has scheduled for this year. In addition to this hearing, the Commission will also be holding hearings on the following topics:

language
literacy
foreign language instruction
teacher education
college admissions
education and the student's life work
education for gifted and talented students

It is hoped that these hearings will provide information which the Commission can use in developing its final report, that they will enable us to identify common themes and problems in American education, and that they will provide as broad an opportunity as possible for interested members of the educational community and the public to bring to our attention their views regarding the issues in American education. Finally, we hope that the hearings will help us establish relationships with those individuals who will have the responsibility for acting on our recommendations.

And I think this is perhaps the most important objective of our hearings, to establish these relationships, to somehow evolve a method for implementing the recommendations that our Commission will come up with in its report.

These hearings are but one method which the Commission will use in order to gain the information it needs to make the practical recommendations which it is charged to include in its final report.

In addition to these hearings, the Commission will organize symposia and forums on specific topics. And it will commission a number of papers on a wide variety of topics related to educational quality.

These topics will include the quite specific issues outlined in the Commission's charter which requires us to pay particular attention to the following:

Assessing the quality of teaching and learning in our nation's schools and colleges; comparing American education with that of other advanced nations; examining the relationship between college admissions requirements and high school success; identifying particularly effective educational programs; and assessing the degree to which social change in the last quarter century has affected student achievement.

Before introducing our witnesses for the day and saying a few words about the format we hope to follow in this hearing, I do want to touch upon the importance of the topic we are considering today.

It is not, I think, to much to say that the strength of our technological and scientific enterprise will do much in the coming decades to determine the economic well-being, security, as well as the health and safety of Americans.

That enterprise rests on at least two pillars. The first is the inventiveness and competence of professional scientists and engineers who design and maintain the systems making up the enterprise. And the second is the overwhelming remaining proportion of the population who do not become professional scientists and engineers, but who need to understand science and technology if they are to function effectively as technicians, repairmen and technology users in business, government and the armed services.

I hope that today we will be able to explore not only the sophisticated training which is provided to the most capable of our students so they can pursue careers in science and technology, but also the quality of education which is provided to the rest of the population who will not enter scientific careers.

Because it is my sense that the relatively few students interested in science and education careers are studying and learning as much science and mathematics as they have ever before.

However, it appears that the larger body of students is ending the study of this subject at earlier ages and performing less and less well at tests of their knowledge.

If I am correct, several troubling consequences may follow from this state of affairs:

- Today's secondary school students may not know enough to function effectively in an increasingly scientific and technological society.
- The pool from which future scientists and engineers can be drawn may decrease as more and more students end their education in science and mathematics after the tenth grade, thus effectively eliminating the possibility of careers in these areas.
- Students from low income families and high school girls may forego potential professional careers in science and technology if they do not receive an adequate rounding in these subjects throughout high school.
- The remaining competitive edge we enjoy in

relation to such countries as Japan, West Germany and the Soviet Union is in danger of being lost if we permit the declining emphasis in science and mathematics in secondary schools to continue.

. The nation may lack a citizenry capable of participating knowledgeably in matters of public policy in science and technology. The ability of scientists to contribute to our society and prosperity requires better understanding on the part of our citizens.

The hearing we are convening today therefore is of interest to me as a practicing professional scientist, but it is also far more than that. Education in science, mathematics and technology is of profound significance to every one of our citizens and to our society and to our nation.

We are privileged to day to hear from a number of distinguished experts on the quality of education in science, mathematics and technology education.

In order of appearance this morning, our witnesses will be Dr. H. Guyford Stever, National Academy of Sciences. He has had many other positions of high policy level in the United States Government.

Dr. Bernard M. Oliver, Hewlett-Packard Company; Dr. Henry L. Alder, University of California, Davis; Ms. Sarah E. Klein, National Science Teachers Association; Dr. Harold D. Taylor, Hillsdale High School, San Mateo, California.

And I trust that we can keep this proceeding relatively informal. A stenographer is present and will keep a record of the exchanges between the witnesses and the Commission.

I suggest that we proceed in the following manner. Each witness will have 15 minutes in which to make a statement. And I would hope that each of you will be able to summarize your prepared remarks in that time.

Your complete statements will be included in the written record of the hearing. After we have heard the statements from the entire panel, we will have questions from the Commission Members and comments by members of the panel regarding the remarks of other panelists.

This afternoon, we will hear from individuals who will tell us about problems and programs in science, mathematics and technology in which they are currently involved. I will announce the names of these witnesses when we reconvene after lunch.

During the latter part of the afternoon, there will be time for members of the audience to present five minutes of testimony on specific examples of educational excellence. These statements may address either today's topic or other topics related to the pursuit of educational quality.

If you are interested in testifying during that time, please fill out an index card at the registration table during the morning coffee break. A schedule of witnesses will be announced before lunch.

We urge everyone who is interested in testifying to submit testimony in writing, since we can only hear from a limited number of witnesses today. The record will remain open until April 11.

Now, I would like the other Commission Members on this panel to introduce themselves.

MS. LARSEN: My name is Yvonne W. Larsen. I am the immediate past president of San Diego Unified School District and I serve as Vice Chairman of this Commission.

GOVERNOR QUIE: I am Al Quie, I am Governor of the State of Minnesota.

MR. SOMMER: My name is Jay Sommer. I am the National Teacher of the Year and I teach foreign languages.

MR. FOSTER: I am Charlie Foster, President of the Foundation for Teaching Economics in San Francisco.

MS. GORDON: I am Shirley Gordon. I am President of the Highline Community College in Seattle.

DR. SEABORG: Thank you.

Now we will start the morning's testimony. And in order to help the recorder, would each of you as you begin your testimony identify yourself and your institution.

STATEMENT OF DR. H. GUYFORD STEVER

NATIONAL ACADEMY OF SCIENCES

DR. STEVER: Dr. Kennedy and Dr. Seaborg, members of the Commission, and ladies and gentlemen, I am Dr. Guyford Stever, Chairman of the Assembly of Engineering of the National Research Council of the National Academy of Sciences. It is an honor to be asked to testify here.

You members of this Commission are to be envied the importance of your task. If you can only give a road map for the next ten or fifteen years in education, you may have attacked the most important social problem we have; certainly the most important problem we have in science and engineering is science education.

The agreement between society and its individual members by which society provides high-quality educations must be one of the finest social contracts that we have today. Though our first requirement of our educational institutions is to inculcate general literacy, the schools also bear the heavy responsibility of teaching science and technology. Our science and technology have been principal engines of social change and progress in the last two centuries, and particularly in the last 35 or 40 years, and our educational system deserves a lot of credit for that.

I think our quality of life, our individual health, our economic strength, and the increasing number of opportunities for leading interesting lives have been greatly furthered by our progress in science and technology. And it is important for people not in science and technology to know that the scientists are still producing many, many results that will keep that process going. There is no let-up in the production of science.

Today, we want to discuss the present and future needs of science and technology from the standpoint of the educational institutions. Let me talk a little bit about some of those needs, and let me begin at the mundane end, the technological end of all technology and science.

You know, much of the technological infrastructure that we are accustomed to -- the roads, bridges, urban transportation systems, railroads, water supplies and so on -- are growing obsolete and old, and our society has not done a good job of replacing them. Replacing the technological infrastructure of the country will be a very large job. Furthermore, many of our factories are growing old along with our manufacturing technologies. Again, we must refurbish and renew them if we are going to stay competitive and strong economically and otherwise.

But fixing up the old is not the only task for which our society will require engineers and scientists; as I said, many new results are also promised. Most frequently cited among the emerging fields that are going to change society a great deal is information and communications. It is already changing so many of our ways, such as the ways secretaries type, correct, edit, and reproduce letters or documents. The ways managers of countries and companies and other organizations run their far-flung enterprises all over the world have all been changed too by instant communications; they have become more centralized.

Others, who dream even farther into the future of this revolution, predict that people will not travel on business as much as they do today, that they will do just as well at business interchanges by using communcation systems. Involving computers in that process will give people the ability to do their own work at home or far from crowded urban centers. Man is only beginning his symbolic relationship with the computer and the emerging communications.

Another far-reaching revolution is in the field of biological sciences. Biologists have already brought genetics to the point at which they can modify plant and animal life, and even construct it. There is no reason that this resolution will result not only in new foods, new medicines, and new ways of producing goods, but also in great enhancements of our understanding of how the human system works, and of our preventive medicines. Environmental and resource studies also represent a very fertile field. This is the tenth anniversary year of the "limits to growth" concept, so-called from the title of the Meadows' book supported by the Club of Rome. Those who developed these ideas and espoused them were recently at a meeting, and they were rather pessimistic because they didn't see any adequate effect on the human race with respect to reducing or limiting resource consumption and population growth.

There are another group of people who don't believe that is the way the problem should be attacked, and I happen to be among them. I believe, with others, that we can find substitutes for our limited resources, and we can find new ways of doing things that will save us from "running out" in the future. (Of course, I don't know of anyone who believes that unlimited population growth can be sustained forever.) Science and technology will be increasingly called upon by society to find cleaner, more efficient, and more conservative ways of making progress.

Just think, for example, of our air transport system. All of the aircraft in that system should be replaced with more efficient ones, and some of the science and techology to do that are already appearing.

The changing international scene in science and technology in itself provides further persuasive reasons why the United States must continue to be strong in both science and technology, rather than slackening the pace of their advances in those fields. In my generation of scientists, right after World War II, the United States attained such a dominant position in science and technology that when we recently lost this lead we were surprised. Some people even went into shock.

For a few decades this country was the only leading country who had its industrial plant, its labor system, its educational institutions, and all the other things that make a country strong that had not been badly dislocated by war. Our country also had other strengths -- the freedom of opportunity and the rewards of careers in science and engineering that allowed scientists and engineers to prosper.

That could not last forever. For the life of me I don't know why anyone was surprised that it didn't, because other countries have expressed very strongly the belief that science and technology are the roots by which they can attain economic strength and better lives for their citizens.

It is a mistake to consider that our people are any stronger intellectually than others, or that our educational institutes have all the secrets. There are other very strong nations, with intelligent citizens, good educational traditions, and strong work ethics. They are steadily and strongly catching up in science and technology.

Though our overwhelming lead has gone, most of the scientists I know still believe that we are either preeminent or on a par with the scientists of other countries in practically all scientific fields, and that in total we are still scientifically the strongest.

We must maintain that strength. Though the application of a given piece of scientific knowledge, resulting economic rewards do not necessarily go to the nation first to discover that knowledge. There is a good chance that the first to discover will be the first to invent and apply.

On the technology side,however, there is a different dynamic apparently. For technology is pervasive and is often the principal ingredient in international industrial competition. The need to strengthen ourselves in that competition with the advanced technological nations is now well recognized, and it has been mentioned before. However, in this international arena, another strong force is emerging -- the newly industrialized nations and other emerging nations. One of the best things that is happening in the world today is that more and more of these nations are beginning to participate in science and technology. They are using it to strengthen their economies, to make their countries better and stronger. Newly emerging nations like Brazil, Taiwan, Korea, Mexico, Singapore, and Israel are increasing their shares of world output, and they are being followed by others.

Now, the most comforting thought in all this is that when these new nations learn to participate more in science and technology, they will have not only goods to export, but also stronger economies for imports. And there will be more world commerce for everyone to participate in. However, these international changes will pose challenges for many decades, we need to keep our education in science, mathematics, and engineering very strong.

From what I have said, it may appear that society is asking, on the science and technology side, that the educational system concentrate on educating professional scientists, engineers, and mathematicians. Certainly that is needed, but there are other needs in scientific and technological education. Two groups in particular should be considered. First, the workers in our factories and our offices and even the people in our homes are finding their daily lives affected more and more by high-technology devices. Just think of how the secretaries are turning from typewriters to highly complex and very productive word processors. The other skilled workers of the world are also changing from doing a lot of things themselves to maintaining and constructing and operating highly sophisticated machines; just mention the word "robot," and you get the idea.

The second group is all educated people. We must have an educated electorate, informed about science and technology issues. Science and technology are becoming more and more powerful in the everyday affairs of citizens. Our political leaders and the electorate need more understanding of the processes by which science and technology are carried out and of the kinds of products they produce. These technological products will continue to change society, and unless managed properly they will result in harm as well as good. We must promote general scientific literacy for these reasons.

And now to sum up the first part of my statement, let me say clearly that we must maintain the health of our science and technology. We cannot do that without strengthening our educational institutions at the high school, college, and graduate school levels, so that graduates of our schools may have lives that are interesting and profitable, and may have the satisfaction of contributing to social progress.

I have dwelt on the side of the educational social contract that represents what society wants from this contract. But what must society contribute, and for what should it aim?

The science and technology that we will do in the future will need unusually, highly creative people. They are scattered throughout our society; you can name lots of them yourselves. Some fraction of our students, who have the innate creative ability for science, must be recognized early and given opportunities through the educational system to express their talents. A broader group of students, who are going to need the capability to solve problems using all the necessary sciences and arts (including many mathematical and technical tools), must also be trained. Finally, all students, because they will work in a technological society, will require general scientific literacy.

Let me point out that my colleagues in science and engineering who are outside the educational world have become very deeply concerned about the ability of American education to produce these vital results. Most of my colleagues believe that the problems of the university and college system are primarily those of finding financial support, and that there is going to be an even greater strain on that support.

However, by and large, most people think that they know how to do the job. In the secondary and primary schools, though, much more work needs to be done.

In preparing this testimony, I ran into a problem with which the members of the Commission are no doubt familiar. The reports pile up, giving statistics showing that we are falling behind our international competition. I planned to refer to a few in my testimony, but then I realized it was a hopeless task. Anyway one looks at it, one can see that we are in for a rough time ahead with respect to our international competition in schooling, in terms of the numbers of people taking courses, the numbers of people majoring in science, and other indicators.

I would like to stress here,briefly, the importance of inspired teachers and exceptional school principals and administrators. We depend on them very heavily at present, and we should somehow expand the kinds of things that lead to their success. I have mentioned a few of them.

I also think that mathematics, as one of the basics of primary and secondary education, deserves a very high priority. Saunders MacLane, a great mathematician, gave me a report, in which he listed these things that all of us do all the time that are mathematical in nature:

counting
measuring
shaping
forming
estimating
moving
calculating
proving
puzzling
grouping

All of us do those all the time, and the better we do them, the better we can live and earn our way.

If mathematics is basic, physics, chemistry, and biology are hardly less so. One of the sad things to me about the changing picture in government is that the National Science Foundation has had to drop out of its support for the teacher training institutes and the science support for research, at colleges and universities and in industry. If the National Science Foundation cannot resume this support, we will have to find other sources of funds. I have a microscopic suggestion as to a grass roots approach to this problem; people who need scientists -- the industrialists of the country -- must work together with the school systems. If each of us sat down with the head of the science department and the head of the mathematics department, to have dinner and talk over their problems, it might help a little. Then if we could get the companies of the country, to ask each general manager to sit down once a year with the mayor, the principal of the school, and the heads of the science and mathematics departments and talk over their problems, those teachers would begin to see more support. Industrial concerns might even put together some of their own institutes locally.

I am sorry I have had to rush, Mr. Chairman, but thank you.

DR. SEABORG: That is fine. You stayed within your time limit very well.

The next speaker is Dr. Bernard M. Oliver. I would like to say a word about Bernie's appearance here today.

When I called him to ask whether he would make an appearance here, he told me he had another engagement. And I must say that I just held him on the phone until he agreed that this was more important than his other engagement. I guess he figured he couldn't get anything done that day if he didn't say yes.

So I think we all are grateful to you for changing your plans and coming. Thank you.

STATEMENT OF DR. BERNARD M. OLIVER

TECHNICAL CONSULTANT, HEWLETT-PACKARD COMPANY

DR. OLIVER: Than you, Glenn. I do recognize the importance of today's hearings, and I feel honored to be chosen by the Commission to address you.

I am humbled by the task that you are all facing. It is an extremely important one and I hope that my remarks will be interpreted in a positive sense because I am going to be very critical of our educational scene.

But even as I criticize, I am fully cognizant that anything one says about education has exceptions. We have in the room today some of the people from Palo Alto School District whom I respect very much, I don't want them to feel offended as I point out some areas of deficiency because I recognize that there are areas of strength as well.

But if we are to move ahead positively, we don't want to concentrate on the areas of strength. We want to look at the areas of deficiency. So, without apology, let me begin my comments.

I was interested to have Dr. Kennedy mention the importance of scientific literacy. I agree that it is extremely important that the populace as a whole comprehend what science is and be somewhat knowledgeable about it.

Some of our issues that are so hot today, such as the nuclear power issue, for example, would be very different if there were greater scientific literacy. The phobia that exists about nuclear power is based on fear and ignorance.

If we had more scientific literacy in the country, we would be in a different position with respect to energy.

I learned yesterday from the director of the public understanding of science of the National Science Foundation, who happens to be in our audience that, under the broadest definitions that one can make, the scientific literacy in this country at the present time is in the order of five percent.

In other words, the people that understand what science is about even in a vague way -- don't have any great knowkedge of science but just understand what science is about -- number about one for every 20 citizens.

That is a pathetic situation and I think it is something that has got to be corrected. That is really what your job is.

My direct contact with public schools began in 1953 when my first child enetered kindergarten, and ended about 1971 when I retired from the role of board member of the Palo Alto Unified School District, a span of nearly two decades. My last contact was, as I say, in 1971.

I spent about 10 years trying in vain to move education ahead, pushing on a glacier, but with relatively little effect.

So what I have to say may be somewhat out of date. But I don' really think so. I don't think there has been all that much change since I left.

My concern about our public schools began in 1955 when I discovered that my first child, who was by then a second-grader, couldn't read. She was memorizing her books and pretending to read them for her friends, but she was not able to read any new material.

My responce probably should have been to discuss this with her teacher. But my actual responce was to go to the Cubberley Library of this institution and draw out the 1916 reading series written by Emma Gordon by which I had learned to read.

I got a rubber-stamp outfit and some Bristol board and I made up the charts that were required in this system and the flash cards and all the other things that were needed.

Every evening before supper, Karen and I had a little reading session. Eight weeks later I stopped this program, not because we weren't making any headway, but because by then we discovered that almost every night we had to go into her bedroom and turn out the light around midnight because she was reading everything she could get her hands on. She was also writing.

Now, why was my attention better than those of the professionals? I asked myself this question. When I discovered that her inability to read was pandemic in our schools, I decided to run for the school board.

It happened that in the interregnum that existed when I first came on the board, board members took an unusually active role in the school system. Together with some professionals who were there, we developed a reading system for the Palo Alto schools.

It got published eventually and was distributed nationally. The experience that we had with it was that at the end of the first grade, our first graders had developed a reading vocabulary based upon word attack skills that gave them a vocabualry of about 2500 words, as compared with the 200-word vocabulary that was produced by the then-existing systems.

At the end of the second grade, they could read virtually any word that they used in their speech. And I will say, without fear of contradiction, that for some reason there were no dyslectics in these classes.

Now, you would think that primary grade teachers would be eager to try so promising a method. But that was not the case. Whether it was because it was not blessed by the priesthood or whether it was because it would require them to abandon old concepts and try new ones, I don't know. I don't know what the reasons were but they did not accept this method, in fact, they resisted it.

In 1965, I visited the English-speaking school in Moscow. I was over there on professional society business and we were invited to attend the school and witness the educational scene. I was vastly impressed with what I saw.

I saw first and second graders writing Cyrillic script in ink and the results were calligraphic. The corrections that were made on their work were very minor to my eve. Their work was beautiful. There were no crudely scrawled block letters. Their penmanship was excellent.

There I heard first and second graders address us in correct English. There I saw a disciplined class rather than the chaos I saw in our own district at the time.

The same had been true when I vistsed Japanese schools in 1963. There is no question that the standards of education in the public schools in both of these countries are much, much higher than they were at that time in the U. S. A., and I believe they are higher than they are at the present time.

Their teachers seemed to me to be better trained. There was little, if any, educational nonsense about what they did. They venerated the subject matter they taught, rather than the method. And the results were impressive. I think they were working harder and the results were paying off.

Now, there is also no question in my mind that the phenomenal rise of Japan's economy and technology would not be possible without the superior schooling that these kids were receiving at the time I visited them.

I think the foundations for what we are seeing today were laid at the time I was looking at their schools. They have gone ahead to achieve. I think our children could do better than they do, if given comparable training.

If Russia had a decent political system, I think they might be outstripping us as well. Because there is no question but thet their educational foundations were equally solid.

I would encourage this Commission to ascertain the validity of what I have just been saying by making actual visits to these countries. It is something you have the power and the right to do, and I think you should do it. I think you should see for yourselves firsthand what is going on in the competing countries I have been mentioning.

I hope that this Commission's concern over the quality of math and science education will not cause you to duplicate some of the follies of the post-Sputnik era.

There is no question that some of the

materials developed in that time were very good, with the emphasis on understanding rather then rote. That was very well conceived.

But there was also introduced at that time a degree of abstraction in certain subjects that removed them from the world of everyday experience and made the value of the subject seem questionable.

The "new math" is an example of that. It turned a lot of youngsters off. I think it did more harm to math education than any other single factor.

Year after year, the students who suffered this approach learned about sets and intersections and unions and things like that; the banalities of introductory set theory. And year after year, they repeated these same trivia because they only got about a quarter of the way through the text each year.

So each year they had to start all over again at the beginning. Ninety-nine percent of those students will never have any occasion to use the concepts of set theory. And I ask: What possible excuse is there for spending so much time in schools on these things -- so many public school hours on such a subject?

Now, there are a lot of problems that have gone on for a long time in public schools. Tenure and the trade unionism of teachers prevent the upgrading of staff.

That is a serious problem.

But the schools are decreasing in their enrollment. It is not possible to keep the best teachers. You know who they are and you can't keep them. You have to fire the last ones to be hired. Seniority is the overriding principle.

A lot of teachers, in fact the majority, never left the school scene for the real world. They came from being educated themselves to being educators. In a sense, they have lived in a world apart.

I think this results in a certain amount of inbreeding and a certain distortion of their values.

A lot of teachers in their eagerness to communicate with the young descend to their level rather than providing adult leadership. I think that is a mistake. I think they should be adult figures to be emulated.

There is curriculum chaos, as well as classroom chaos. The times of change and turmoil have led us to present things not necessarily in a sequential fashion, where one step leads to the next, but rather in a way that jumps about and puzzles students rather than letting them learn easily in an orderly fashion.

Finally, there is always the danger of endoctrination, rather than education, in the classroom. And that is something we have to guard against.

To some extent a policy of egalitarianism exists in which we concern ourselves overmuch on the less able and spend less time than perhaps we should on the gifted.

And I think one way to correct these problems is not by study commissions such as this, talented though you may be. Regulations will not correct all these problems.

Some think that by forcing the public schools to fight for survival against real competition on a fair footing might be a way to correct these problems.

Rather than support public schools, some argue that the state should support the child's right to education by financing that education whereever the parents chose so long as the school meets certain standards.

Competition is a good thing. Darwin thought highly of it. If the schools had to compete for attendance, their success would be determined by their performance as judged by the parents who, after all, on the average are very concerned about the child's education.

This "free market" undoubtedly would correct, overnight practically, much of the nonsense that goes on today. But it would not do so without a price.

There are some problems that attend the voucher system, as it is called. Private schools, you see, can be selective about the children that they admit. And if the voucher systems were to be put in effect, some fear that soon only the dregs would remain in our public schools.

Now that is a real problem and I don't know how to avoid it except by honoring vouchers only at those private schools that agree to accept everyone.

But I would remind the public schools that the present trend toward private schools, if it continues, is going to bring about a de facto segregation of this kind, leaving them with the dregs whether there is a voucher system or not.

So if the public schools want to continue to attract the capable, they have got to clean up their act to a great extent.

In short, I would like to summarize by saying that I don't believe we are going to materially improve math and science education until we improve the teaching of skills in the primary grades, and until we improve the content and teaching of the subjects at the secondary level using teachers that are trained in math and science themselves.

Physical education instructors cannot educate in physics.

Thank you.

DR. SEABORG: Thank you.

The next speaker is Dr. Henry L. Adler. He is also representing the Council of Scientific Society Presidents. That is an organization composed of the presidents of the Scientific Societies in our country.

Dr. Adler.

STATEMENT OF DR. HENRY L. ADLER

COUNCIL OF SCIENTIFIC SOCIETY PRESIDENTS

DR. ADLER: Dr. Seaborg, Members of the Commission, I represent the Council of Scientific Society Presidents of which I became a member as President of the Mathematical Association of America. I served as Chairman of the Council of Scientific Society Presidents in 1980. I am still a member of its committee on science education.

I am a professor of mathematics at the University of California at Davis.

It is gratifying that your Commission has identified science, mathematics and technology as requiring separate consideration because its problems are substantially different from -- indeed in many cases diametrically opposed to -- those of education in the other subject areas.

It is essential to be aware of these differences. I would like to take a moment or two to point out these differences and therefore pinpoint the special problems of education in science and mathematics.

1. There is a crisis in pre-college education in science and mathematics, more than that in any other area, that is a serious threat to our nation's economic, political and military strength.

Industry, business, and the military commonly report that the competencies of new employees and recruits are inadequate in light of the increasing technological demands of our age.

As already has been pointed out by your chairman, the nation's economic health and security depend upon scientific research and technological development and the well-educated men and women who carry them out. Motivating young men and women to be interested in science and assuring that they have the opportunities to pursue more advanced scientific study in college and graduate school are, therefore, vital to the future well-being of the nation.

Accomplishing these tasks is one of the primary goals of high quality science and engineering education.

2. There is a dynamism in science and mathematics education whose constantly evolving content and methodology makes it a unique and valuable endeavor.

Scientific education depends upon data which are generated experimentally, upon development of healthy curiosity among students, and upon confident teachers who can help these students understand these data, extrapolate from them and draw logical, well-reasoned conclusions from their efforts.

These very aspects, which make the study of science so fasinating to its practitioners, make it inappropriate to codify it into a fixed, static curriculum.

The framework within which science and mathematics education is carried out must be valid but fluid, must allow for individual interests and experiments, and must be thought-provoking, not merely knowledge imparting.

3. There is a critical shortage of secondary science and especially mathematics and physics teachers, though the shortage is only marginally less severe for chemistry, earth science and general science.

According to a 1980 survey conducted by the State Department of Public Instruction in Iowa, a shortage or critical shortage of mathematics teachers was identified in 35 states.

By 1981, this figure had risen to 43. In physics, the 1980 survey reported shortages or critical shortages of teachers in 43 states. By 1981, this figure was 42 with six more states characterizing the shortage as critical. Chemistry teachers as of 1981 were in short supply in 38 states.

The Association for School, College and University Staffing confirms these figures in a separate survey that shows that no region of the country, except for some reason Alaska, has an adequate supply of qualified mathematics or science teachers.

One consequence of these shortages is that secondary schools are employing unqualified teachers for mathematics and science classes. The recent survey of the National

Science Teachers Association -- NSTA, for short -- of secondary science teachers found that approximately one-third of the respondents had majored in fields other than science and nearly one-half of the teachers had not taken a college science course in the past five years.

To add yet another dimension to the currect shortages of qualified science teachers, the average age of science teachers responding to the NSTA survey mentioned previously was 41 -- a clear indication that an insufficient number of new science teachers are entering the profession.

Also, more than 25 percent of hte teachers responding to the survey expected to leave teaching in the near future.

More recent information from NSTA indicates that, for some regions of the country, the majority of newly-employed science and mathematics teachers were unqualified to teach their subjects and were being employed on an emergency basis only.

Incidentally, up to 84 percent were reported unqualified in the Pacific states for example.

4. There is a substantial increase in enrollment in undergraduate mathematical sciences courses at both the secondary and college levels.

Among reasons for this increase in the secondary schools are desires for minimum competence and the resulting remedial courses needed to bring students up to those minima -- for example, in Florida -- the increased number of girls taking higher mathematics courses, the increase in computer science enrollments, the increase in university and college admissions requirements in mathematics.

For example, the Advisory Commission on Articulation between Secondary Education and Ohio Colleges has recommended that a student desiring to be admitted to a private or state supported four-year college or university in Ohio should have a minimum of three years in mathematics.

The University of Washington will change its admission requirement in mathematics from two to three years affective fall of 1984. And the University of California plans to do the same thing in the fall of 1986.

An additional factor contributing to the increase in enrollments in secondary school mathematics courses is the pressure from colleges where an increasing number of majors require at least three years of high school mathematics.

Statistics show, for example, that at UCLA 60 percent of the graduating seniors in 1981 had majored in fields which required for entrance at least three years of high school mathematics -- that is, mathematics through intermediate algebra.

The same phenomenon exists for enrollments in college and university courses in the mathematical sciences. The following highlights from a survey of the Conference Board of the Mathematical Sciences published late last year, illustrates this:

> "From 1975 to 1980 mathematical science course enrollments in universities and four-year colleges increased by 33 percent compared to an increase of only seven percent in fulltime equivalent undergraduate enrollments in these institutions.
>
> "In the same period, enrollments in computer science courses in these institutions have tripled."

5. There is a critical shortage of United States graduate students in science and engineering, including the mathematical and computer sciences.

A 1980 report of the National Science Foundation indicated that 26 percent of full-time graduate students currently enrolled in al science and engineering programs were foreign nationals and that for all engineering programs the figure is 71 percent of those currently enrolled.

In 1980, 46.3 percent of the engineering doctorates were awarded to foreign nationals according to a recently published NRC report.

In 1980, in mathematical and computer sciences, 47 percent of the currently enrolled full-time graduate students were foreign nationals.

Now, several of the previous speakers have already reported on the decline in student performance. So I will say very little about that. But you all know that the past two decades have seen a pronounced deterioration in the academic performance of students headed for college.

The only group of students whose performance has not declined are those at the very top. Highly motivated students continue to come to universities very well prepared, in some cases even better than the students a generation ago.

Many of them are the product of the very successful Advanced Placement Program of the College Board.

The decline in the performance of the great majority of students has been measured by test scores. It is also perceived by faculties throughout the United States as shown by the recent widespread increase in the use of remedial programs in colleges and universities.

Data from the Conference Board survey, which I just mentioned, show that enrollments in remedial, that is high school level, courses in four-year colleges and universities in the United States -- this refers to mathematical remedial courses -- rose in the period from 1975 to

1980 by 72 percent compared to only a seven percent increase in undergraduate enrollments in the same period.

Yet remedial courses are only rarely effective in curing the ills of inadequate mathematical preparation. Let me explain.

Typically, a student who has, for example, failed for whatever reason to take the intermediate algebra course in high school and needs this course as a prerequisite at a college or university, will take it as a remedial one-quarter course in college.

Now, the typical high school intermediate algebra course meets five times a week for about 36 weeks, or a total of 180 hours.

On the other hand, the corresponding college remedial course typically meets three times a week for 10 weeks, or a total of 30 hours, that mean one-sixth of the time allotted to it in high school.

How the typical student who was either not motivated enough to take or unable to pass a one-year high school course in intermediate algebra can be expected to succeed in taking the same course in the university in one-sixth of the time allotted to it in high school, I have always found very difficult to comprehend.

In addition, aside from being often ineffective, remedial courses offered in colleges or universities are very expensive to the institution and divert previous resourses and energy from the proper function of the institutions of higher learning.

I want to conclude this by making a few recommendations:

The state of precollege education in this country is stirring widespread and serious concern in the scientific and engineering communities. Paralleling this concern are feelings of helplessness and frustration engendered both by the magnitude of the problems and the absence of mechanisms for addressing them.

Yet, mechanisms do exist and their implementation is achievable without excessive effort and at relatively modest cost. But they do require badly needed leadership at both the federal and state levels.

Clearly, solutions need to be considered which address the problems in the long run as well as in the short run.

Let me first briefly address some recommendations for the long term.

The available data clearly indicate the need to find ways and means to increase the number of qualified persons to become teachers of science and mathematics and to be retained in the profession.

These problems have been addressed in an exemplary fashion in the 25 recommendations recently announced by the Task Force on Higher Education and the Schools in a report to the Southern Regional Education Board entitled "The Need for Quality."

Two of these recommendations seem especially appropriate in the solution of the problem of the acute shortage in the supply of science and mathematics teachers.

Let me read these two recommendations. They are very brief.

Number 1.: States should develop an array of incentives to attract science and mathematics teachers, including scholarships or loan programs for prospective teachers tied to the teaching of these subjects within the state, following the established pattern of state subsidies to train medical personnel in short supply.

Number 2.: States should modify certification requirements to permit graduates in mathematics and science who lack professional education preparation to teach at the secondary level, with safeguards to insure the quality of instruction.

Certification should also accommodate teachers in related surplus fields to teach mathematics and science, with refresher courses as needed.

I would like to make only one other recommendation for the long term.

Number 3.: The shortage of science and mathematics teachers make it especially important that these teachers should be in the classroom teaching these subjects and not be used for other tasks in the school.

Available estimates indicate the surprisingly large loss of teaching hours in mathematics in junior high school resulting from the use of these teachers for other tasks.

School administrators should, therefore, be urged to insist that teachers trained in science or mathematics are used in the classroom to teach these subjects and not be used for other tasks.

Finally, I would like to make similarly three recommendations for the short term. Widespread consultation on possible mechanisms for addressing the acute problems of science and mathematics education has convinced us that the following three recommendations are likely to produce the best results in a relatively short time.

Number 1.: The most serious of the existing problems is the shortage of pre-college mathematics and science teachers. This nation cannot afford to wait till students now entering college are ready to start filling the many vacant positions.

We therefore recommend that programs be organized for in-service training and retraining of current middle level and secondary mathematics and science teachers who are inadequately prepared to teach in these subjects, but have the capacity to profit from such programs to strengthen their mathematical or scientific preparation and teaching skills.

Such in-service training could be intensive summer institutes followed by in-service training during the academic year. It could also consist of academic year institutes or other types of institutes suited to local circumstances.

Participants in such institutes should be selected with the objective to increase the pool of teachers competent to teach mathematics and science.

This means that preference should be given to those with some competence in mathematics or science, where additional training would make it possible to teach more advanced or more thorough courses in these fields.

Teachers already able to teach advanced courses in mathematics or science should not be considered candidates for such institutes, as additional training for them would not increase the pool of qualified mathematics and science teachers and indeed might increase their qualififcation sufficiently to provide an incentive to leave high school teaching for other positions, for example, in a two-year college.

To maximize the impact from such institutes, some participants in a summer institute who have distinguished themselves for their enthusiasm and interest in improving student mathematical preparation might be designated as Fellows and asked to conduct intensive in-service activities within their school district for which activity they would receive an additional stipend.

Instructors in these institutes would be primarily college and university faculty members familiar with the needs of pre-college education in mathematics and science and especially capable to motivate and inspire the participants.

One of the most beneficial effects of such institutes would be the resulting interaction between college and pre-college teachers which has become almost nonexistent with the discontinuance of the NSF institutes and which is so vital to prevent the feeling of isolation and neglect among pre-college teachers.

Number 2.: It is widely recognized that the students' attitudes toward mathematics are generally formed by their experiences in elementary school.

The influence of the elementary teacher, therefore, is of paramount importance. Not every elementary teacher, however, can be expected to convey a positive attitude toward mathematics to his or her students, and, indeed, many don't.

We therefore recommend that programs be initiated to put mathematics specialists into the elementary schools. They will generally teach the mathematics courses in grades 4, 5 and 6, and some feel that they might be used earlier.

Mathematics specialists could be recruited from elementary and lower middle grade school teachers with an interest in mathematics, some competence in it and, especially, motivation to work in and enthusiasm for mathematics.

Such teachers could be given special training either during the summer or on weekends or other appropriate times during the academic year to qualify them as mathematics specialists in the elementary schools.

Training of mathematics specialists has assumed added importance as a result of the changes in the very nature of arithmetic which the computer-calculator age has brought about.

The paper and pencil algorithms will be much less important while estimation and "feel" for numbers, particularly in applications, will need increasing attention.

In addition, test results show that students are not benefitting from their study of arithmetic to the extent they should. They lack problem-solving skills and the ability to determine the reasonableness of answers, partly due to a lack of exposure to elementary, but creative, aspects of mathematics.

There is an urgent need to make arithmetic teaching much more effective, that is, to increase children's "numerical awareness."

This implies the need for the development of new material for both teacher training and the use by teachers in the classroom. The preparation of such material clearly requires federal involvement, as there are no other feasible means for this.

Number 3.: For reasons indicated earlier, efforts to help unprepared students by means of remedial courses and special programs at the university level have generally been disappointing, both to students and to the sponsoring institutions.

In recent years, it has become increasingly clear that university programs which are to effect significant improvements will involve intervention at the public school level.

We recommend specifically that universities and colleges assist public schools by providing them with placement tests to be administered to high school juniors so that they can be advised to make up possible deficiencies by taking appropriate courses in the senior year.

A successful model for such a placement test program is provided by Ohio State University which this year is testing approximately 35,000 students in 219 schools.

Students can request information in terms of requirements at Ohio State University or at the University of Akron this year. In time, the program hopes to include all state-assisted Ohio universities. One result has been sharp increases in senior mathematics enrollments.

A similar project for assessing students' mathematical preparation has recently been launched in California by a joint committee of faculty members from the California State University and the University of California assisted by high school mathematics teachers.

We recommend that these types of assessments be expanded to earlier educational levels to include, for example, assessment of proper preparation for beginning algebra courses since, without proper preparation in arithmetic, a student is most unlikely to succeed in an algebra course.

The institutes proposed earlier should be used as one suitable device to inform participants about diagnostic testing and the use of test results for proper placement of students.

Finally, Mr. Chairman, and Members of the Commission, I would like to inform you that CSSP, the Council for Scientific Society Presidents, is ready to assist you in any way it can in your deliberations.

As you must be aware, there is a widespread feeling in this country that the time is ripe to address the serious problems in science and mathematics education.

We urge you as strongly as we can to seize the special opportunity presented by the existence of this widespread concern to provide the needed leadership for a significant improvement.

I hope you will be able to become the catalyst for the needed reform in the same way as Sputnik did in an earlier age.

Thank you.

DR. SEABORG: Thank you. I am sure the Members of the Commission will take note that you have made a number of challenging recommendations.

The next speaker is Sarah E. Klein, who is the President of the National Science Teachers Association.

I saw Sarah, and I did Guy, at the Science Talent Search in Washington last week. I noticed that Guy, in his prepared remarks that he didn't have time to allude to makes reference to this also.

These prepared remarks I believe are available on the back table for those of you who want to see them. The Science Talent Search is certainly a bright spot in the selection and support of scientists. But, of course, it is only a small part of it.

Sarah?

STATEMENT OF SARAH E. KLEIN

PRESIDENT, NATIONAL SCIENCE TEACHERS ASSOCIATION

MS. KLEIN: Good morning Members of the Commission, Members of the Testimony Panel and friends.

Believe me, I would feel much more comfortable if you were 30 to 50 seventh- or eighth-grade general science students than who you are.

My role this year has changed dramatically from my role of last year. I am a general science teacher and have been for a number of years.

You know, it is very interesting to me because we have come almost full cycle with regard to science education. As I visited other countries this year, it was very flattering to say, "Ah, Dr. Klein, what university are you with? One from the west coast? Are you from Berkeley?"

And I would say, "No, I am from Roton Middle School in Norwalk, Connecticut." Then of course they needed to know what a middle school was and what I was doing as an eighth-grade general science teacher as president of the National Science Teachers Association.

And I am sure the majority of you are wondering exactly the same thing. Have you ever stopped to think why, when you clip or tear from the newspaper, that one direction that you tear the newspaper it goes very easily and the other direction you tear the newspaper you have great difficulty and you get very scraggly edges?

Have you ever wondered why an elastic band stretches? Have you ever wondered why -- well, clap your hands. Do you know how far you traveled when you clapped your hands? Not physically, but on the face of this earth? This earth is rotating at the rate of 19 miles per second. You traveled 19 miles in that one second. These are simple examples but illustrate that the simplest of questions could tell us why we are having difficulty today. Have we as adults stopped wondering? have we as adults stopped our ordinary wool-gathering, as it were? Are we trying to inflict our feelings and thoughts on youngsters in the classroom?

Everyone of us here today is an expert. Everyone of us here today is really in some capacity an expert, or we wouldn't be here. We have expertise that as we talk, we should solve all of these problems.

But then, we would have to inflict our decisions on someone else. Have we educated the general public to accept the decisions that others have made for them? In some ways, I think our education is going through a rebellion because we are rebelling against things -- thoughts, rules, regulations, that others have said that we have to live by. We have practically come full cycle -- as I started with my comments. Others making decisions and expecting the youth of today to carry out decisions tomorrow.

My degree is in home economics. My masters is in education. I have spent a lifetime trying to upgrade, trying to be that better science teacher.

I was told never to teach. Now this is the importance of the supervisor at the college level. When a student has one more semester and they are told do not teach it is very discouraging even in home economics where anybody knows that anyone can teach home economics.

Have you ever tried to tell anyone how to make a dress? Have you ever tried to tell anyone how to straighten a piece of fabric? Have you ever tried to tell anyone how to make a white sauce without lumps. Have you ever tried to tell anyone how to do these things? We have to learn by doing.

The majority of the U. S. populace are not elitists. Physical scientists and physicists are elitists. There are very few in that capacity. Yet the media would have the general public believe that we in science and math are all elitists. You are right, I am not sticking with my testimony as written, but though I have tremendous support of the National Science Teachers Association there is much more to tell. Others can write and put together facts and figures much better than I can.

But I am a classroom teacher. I am the important person. And I am speaking on behalf of not only the 40,000 NST members but I am speaking on behalf of every classroom teacher in the United States and in the world.

I have a tremendous responsibility here in seeking excellence in education. There are critical shortages in math, chemistry and physics. That has been pointed out. There is a decline in numbers. That has been pointed out.

If you want to refer to the chart that Henry Adler referred to, it is on page 3 of my testimony -- the 84 percent of Pacific States. The collapse of support systems, 79 percent of the secondary science teachers have not had a course in ten years. The average age of science teachers is 41; the length of time teaching averages to 16 years.

I could go on but all of those points are brought out in the written testimony.

Another important factor is the low salaries that science teachers get -- and I don't want to limit that only to science teachers. I think we can put every teacher in that category. It is no wonder that a math teacher will leave the teaching profession to join the business and industry profession when they can double their salary in 24 hours by signing a contract with a company.

This year on sabbatical, the City of Norwalk was very generous in giving me the sabbatical, and I am grateful to them. The Board of Education did not feel that it would be a year of work away from the classroom. So, consequently, on sabbatical I receive 60 percent salary. $14,000. This is one way of saving money for school districts.

But, nevertheless, salaries are an important factor in teaching and in keeping teachers. There is a decline in the federal support at the pre-college level. This is true, and I think we have to mention this because that was one tremendously unifying thing for teachers -- the fact that there was someone, someplace, somehow, an overall governmental organization that felt that teachers were important and that they deserved financial support through NSF funding.

And I bring you to another point with regard to the United States and the U. S. S. R.. I think the fact that numbers in science are not as important in the U. S. S. R. as we maybe give them credit for being.

I think we have to realize that many -- and I could relate those statistics to you as stated by Dr. Wirzup from the University of Chicago and quoted them on several occasions -- the large number of engineers that are driving trucks in the U. S. S. R.. We do not usually expect our engineers to function in that capacity.

The other thing that we need to remember is that the U. S. S. R. and Japan both have national systems of education. We do not have a national system of education. We have an individual community system. Whatever that community decides it wants its educational system to be, that is what it is.

And there is an accreditation system that, fortunately, we have. But what does your community want? What does your board of education want? I think these are things that we have to consider when we consider backgrounds in education and that we each can have input into our educational processes.

If we have guidelines, if we have a definition of excellence in education, I am convinced that every teacher, and every board of education, would be more than willing to do everything that could to focus that particular community to a standard of excellence.

I think we have sold our teachers short. I think we sell our students short. I believe that any task we give these children to do, they can do it. As adults we do not expect enough of our students.

Mr. Oliver had really experienced and internalized the lack thereof in education through his personal experiences.

Believe me, in talking with George Keyworth, when I said to him, "It is so nice to meet you," and did all the pleasantries, then I said, "And do you have a family?" "Oh, yes."

"What ages are they?" Well, one was ready to go in the fifth grade and one into the seventh. And I said, "Oh, my goodness, it is exciting. You are a middle school parent. I am delighted to meet you."

He said, "Well, you know, this really bothers me." He said, "I understand that that middle school is in serious trouble, educationally."

I said, "Yes, it is. And what can you do to help us?" An eighth grade general science teacher really can make education become relevant to parents. It makes education come right back to, goals and standards for what my child needs to learn.

My children went through the public school system. Hindsight, we should have put one of them in a private school. But then he couldn't have played football for the private school that we wanted him to go to.

What are the other factors that influence this excellence in education? What is the motivating factor? Why do children stay in school past age 16?

Schools are a tremendous social agency. In our definition of excellence, how can we include all of the motivating factors.

Now,again, I am probably on the minus 30 second side, but there is much to say. Personal as well as professional examples. NSTA has its own search for excellence in science programs, to try to identify them. We began this last year when funding for this was not granted through the National Science Foundation. We felt this was indeed important and plan to pursue it and publish our findings.

We will be glad to cooperate with you by identifying where these excellent programs are ongoing.

We are working with the state science consultants. In those states that do not have consultants, we have identified outstanding people in the science education field to help with this excellence in science education.

It is an interesting note that one of these persons that has been identified as an outstanding person to help search for these excellent programs is an elementary teacher. I think that this is important because we need to begin using teachers at the elementary level in connection with excellence in science and mathematics education.

We do have receommendations. We need to be sure that science and math education are publicized. We need to make the community aware of the fact that we do have some good things going on in science and math.

But unless they can see the products , they won't believe us. It is another time where science and math teachers are very elite. We talk to each other about these programs, about these great things that we are doing, but we do not share these good things with others.

And the only things that parents and the community can see are negative things that seem to happen to "my" child.

We need some undergraduate colleges for free teacher training. We need some kind of inservice programs for the capable teachers right now, both summer and academic year. Some sort of an incentive program for these teachers to take advantage of inservice programs.

I firmly believe that if we had a science consultant in every elementary school the science consultant would take the responsibility for seeing that science is taught, our problems would be minimized at the middle and secondary level.

Dr. Morris Shamos, in a talk to business, industry and science educators, June, 1981, pointed this out very clearly and gave us a way this could be done. This is not an original idea.

We need to continue regional resource centers. Examples of excellence that are in existence right now are a resource center in Fairfax County in Virginia and the one that Susan Sprague has in Mesa, Arizona. Susan Sprague is an elementary resource center and Doug Lapp's is more K through 12.

Equipment is outdated, equipment is broken in schools. We need to have an updating of equipment. And this brings us into our age of robotic electronics and computers.

We feel that these are areas where we must pay close attention. These are areas where we can make a difference, if these are addressed.

Yes, I do have children. I have five children, and seven grandchildren. I am interested in excellence in education. I am not going to give up. I will go back to that classroom next year because I am needed there.

Thank you very much.

DR. SEABORG: Thank you very much. I am sure that George Keyworth met more than his match in his encounter with you.

I think the Members of the Commission will also appreciate your presentation with emphasis on your viewpoint as a classroom teacher.

The next and last speaker is Dr. Harold D. Taylor who is representing the National Council of Teachers of Mathematics.

STATEMENT OF DR. HAROLD D. TAYLOR

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

DR. TAYLOR: My name is Harold D. Taylor. I am a classroom teacher of mathematics at Hillsdale High School in San Mateo, California, a position I have held for the last sixteen years.

Prior to coming to San Mateo, I was a mathematics teacher in Patterson, California, Covelo, California and in the State of New Mexico. I have been in public education for 23 years.

I received my B. S. degree in mathematics from Southeastern Oklahoma State University, and my M.A. in mathematics and Ed. D. in mathematics education from the University of Northern Colorado.

I am a member of the Board of Directors of the National Council of Teachers of Mathematics and a past president of the California Mathematics Council, Northern Section.

I am pleased to have the opportunity to appear before the National Commission on Excellence in Education to testify on behalf of mathematics education. I represent the approximately 60,-00 members of the National Council of Teachers of Mathematics.

The Council is dedicated to achieving excellence in mathematics education at all levels, kindergarten through university, and we strive to achieve our goal through the dedication of classroom teachers throughout our nation.

Mr. Chairman, it gives me great pleasure to appear before you today on behalf of all classroon teachers of mathematics. Your Commission's concern for the status of mathematics and science education gives us hope that, working together, we can effect a reversal in the trend toward technological illiteracy in this country, and thus to its threat to our national economy and our national security.

I wish to place my testimony in the following context:

1. The youth of this country is our most valuable natural resource;

2. The classroom teacher is the heartbeat of free public education;

3. Our national economy and our national security are already seriously compromised;

4. Immediate action on the part of both state and federal governments is essential in order to reverse the current trends in mathematics and science education; and

5. The education of our youth must become a pressing national commitment.

The decline in the mathematical ability of entering college freshmen and the resulting decrease in the number of students who elect majors in science represents a crisis in education. The fact that this program exists is documented in a report by Joan R. Leitzel of the Ohio State University to the American Association for the Advancement of Science, and reported in the Chronicle of Higher Education in January 1982.

Recent studies have shown that the United States is lagging Japan, West Germany, Eastern Europe, and Russia in the production of engineers and scientists. For example, in 1979, Japan produced approximately 22,000 electrical engineers, while the United States produced only slightly over 16,000. These figures are in contrast to somewhat less than 12,000 electrical engineers for Japan and slightly over 16,000 for the United States ten years earlier.

While considering these figures, it must be kept in mind that Japan has about one-half the population of the United States. Our domination of the field of high technology is seriously compromised by failure to train engineers and scientists, and thus, our national economy and our national security are surely threatened. We had a trade deficit with Japan in 1981 of $18 billion with a deficit that is projected to go to $20 billion in 1982. According to Project Atlas, Richardson, Texas, 1981, engineers accounted for 6 percent of the bachelors degrees awarded in the United States during 1980.

Comparable percentages are: Japan 21 percent, West Germany 37 percent, and Eastern Europe 42 percent. The American Electronics Association projected that in 1981 U. S. colleges and universities would produce only 43 percent of the demand for new graduates in the electronics industries.

The reasons for the decline in student mathematical ability are complex and difficult to formulate. I believe, however, the primary culprit is our curriculum. At almost all levels of education, our curriculum is geared too low. We teach to the average or below average student, our curriculum materials are directed to the average or below average student, and far too small a portion of teacher time is directed toward those who are capable. Classroom behavior of students is such that a teacher's energy must be directed toward keeping discipline, rather than teaching. School attendance is often a problem. Education is forced to compete with television, sports, electronic games, drugs, alcohol, and sex for student time and interest.

I am thoroughly convinced that our compulsory education laws are antiquated and need replacing. Large numbers of students who consider school attendance to be a jail sentence, and behave accordingly, are forced by law to be enrolled in our schools. Physical, verbal, and psychological abuse of teachers is commonplace on school campuses. Vandalism, including arson, costs schools far to great a portion of their resources, both human and financial. These students cause the public to pay for educating them year after year over the same subject matter and still often graduate illiterate. In short, they are a small minority of the total number of students, but demand a disproportionately large share of the school's time and resources and the public's money. They should no longer be forced to attend traditional schools. Alternatives must be provided them through continuation schools, technical schools, vocational schools, or work groups such as the California Conservation Corps. Legislation must be enacted whereby student discipline can be controlled.

Another factor in the decline of mathelatical ability of students is the long-standing practice of social promotion, especially in the elementary and middle schools. A student's advancement into secondary school often is a function of years spent in school rather than performance in academic subjects. The advancement of a student into higher grades, without the accompanying skills, is an insurmountable obstacle in the way of further academic progress. The second national assessment of methematics has pointed out the critical need for attention to higher-order cognitive skills. Almost every student is seriously deficient in reasoning and listening skills and very few have developed reasonably good study habits by the time they reach the secondary level. A high school diploma often represents time spent in school rather than student achievement. Grade deflation seriously detracts from the value of the diploma and makes college entrance requirements, with respect to grade point average, meaningless.

The attitude of teachers, students, parents, and the public at large, impact the learning of mathematics. Students who want to learn and are prevented from doing so are frustrated and tend to blame the school and their teachers. Parents and the general public, those who provide the financial support for education, blame the schools and teachers for not doing a better job. They have voiced their displeasure at the ballot box by voting down bond measures and voting in tax reform. Teachers feel they are neither respected nor appreciated. In such a setting of frustration and unhappiness, mathematics education cannot attain excellence.

It must be understood by those who criticize mathematics teaching as bland, that educating oneself is a personal responsibility, is hard work, and is often boring. Some of the strongest motivation to which human beings respond is extrinsic rather than intrinsic. Teachers are not trained as entertainers, they are not paid as entertainers, and cannot be expected to motivate students to study mathematics by entertaining them. Critics must understand that the typical secondary teacher of mathematics not only must meet 150 students in the classroom each day, five days a week, but must make and grade tests, evaluate homework, send progress reports or grade reports each month, plan lessons, keep records, write college and job recommendations for students, maintain communication with parents and counselors and administrators, tutor students who have been absent or fallen behind for other reasons, develop and plan curriculum, and numerous other tasks. Meanwhile, they must maintain discipline in the classroom and survive many classroom interruptions.

Some teachers in our classrooms also contribute to the decline in student's mathematical ability. In our elementary schools many teachers suffer math anxiety and pass this along to their students. A teacher who is excellent in other subjects -- and elementary teachers are expected to be expert in all subject areas -- quite often is not a good mathematics teacher. There are some states that do not require an elementary teacher to study mathematics beyond basic arithmetic in grade nine. Poor mathematics teaching is not restricted, however, to the elementary level. Some states do not require that secondary teachers of mathematics study even up to the level they may teach.

Before we can attain excellence in mathematics education, our classrooms must be staffed with well-trained, dedicated teachers. The Association for School, College and University Staffing indicates that 22 percent of all high school teaching posts in mathematics are vacant at the present time. At the same time, the National Council of Supervisors of Mathematics reports that 26 percent of the mathematics positions are filled by teachers who are not certified, or are only temporarily certified, to teach mathematics. As a specific example, in Maryland, a survey by the State Department of Education at the end of 1979-1980 school year estimated that 50,000 secondary students received their mathematics instruction from more than 400 teachers who were not certified to teach secondary mathematics. Howe and Gerlovich in their National Study of Estimated Supply and Demand of Secondary Science and Mathematics Teachers said that 43 of 45 reporting states indicate a shortage or critical shortage of secondary mathematics teachers. Because of the shortage of secondary mathematics teachers and the oversupply in other areas, there continues to be more and more teachers assigned to teach mathematics who have neither the training or the desire to do so.

Kenneth Ashworht, Texas Commissioner of Higher Education, stated that in 1978, in the entire south, colleges graduated 445 mathematics education majors and 7,502 coaches and physical education majors. The 1980 Conference Board of the Mathematical Sciences Survey shows that the number of mathematical science bachelor's degrees with majors in secondary teaching has dropped by 64 percent since 1975. Few people are choosing to become teachers of mathematics. The profession simply is not attractive enough to draw students in sufficient numbers. The salary differential between business and industry and teaching is far too great and the working conditions simply not good enough to attract potential candidates. If we are to attract an adequate supply of teachers of mathematics for our nation, and we must, these deterrants have to be eliminated. William S. Graybeal reported in The Mathematics Teacher in December of 1979 that the average salary of a beginning teacher with a bachelor's degree was only 73.1 percent of the beginning salary offered by private industry to bachelor degree graduates in mathematics and statistics. This ratio has steadily declined and is presently no more than 60 percent. U. S. News and Worl Report has stated that, "Math teachers coming out of college already realize that the $12,000 paid to a beginning teacher is a lot less than the $20,000 that could earn in their first year with some computer firms. What's more, many say they feel more appreciated in private sector jobs than in classrooms."

In February 1982, U. S. News and World Report stated that, "Alleviating the math-teacher shortage is one of the most immediate and pressing tasks facing colleges and school systems." I wholeheartedly agree. The time has come for differential pay to mathematics teachers. Houston, Texas, has already implemented such a plan with no major difficulties and the plan is being expanded for for the academic year 1982-83. The precedent for differential salaries has been set by school districts throughout the country that have paid incentives for teaching in inner city schools. All teachers in short supply should be offered incentives to enter, or to remain in, the profession.

If teachers trained in fields other then mathematics are to teach mathematics, they should be retrained to the extent necessary to become well qualified. All teachers must undertake a continuing education program just as attorneys and medical doctors do. Groups such as the National Council of Teachers of Mathematics and the California Mathematics Council offer excellent opportunities for continuing education through their publications and their many sectional, regional, and national meetings each year. Local school districts, states, and counties have the obligation to offer opportunities for self improvement to classroom teachers. The teacher training institutions must offer summer programs for the continued training of teachers as they once did, under the financial leadership of the National Science Foundation. One of the most important contributions to the strengthening of mathematics and science instruction in this nation was that of the National Science Foundation grants and programs offered after Sputnik in 1957.

The public at large, and especially state and federal governments and courts, must stop expecting our schools to be a major vehicle for social change. Please note that on February 6, the President released his fiscal year 1983 budget proposal with recisions for fiscal 1982. He not only asked for the dismantling of the Department of Education, but that science and engineering education be funded, through the National Science Foundation, for the amount of 9.9 million. At the same time, he asked for bilingual education to be funded, through the same authority, in the amount of $126 million. Bilingual education requirements, bussing for racial integartion, rehabilitation of juvenile delinquents, problems created by a high divorce rate and families where both parents work, and malnourished and abused children are but a few of the social problems that public schools are expected to solve. We are not equipped nor trained to handle these problems.

If given the financial, philosophical, legislative, and societal backing, the problems that exist in public education can be solved. This solution cannot occur overnight.

and since we are currently in a state of crisis with respect to mathematics education, it is imperative that a plan for a solution be formulated immediately and that we, as a nation, dedicate our energies and resources to the implementation of that plan. We must have teachers trained to teach mathematics in the classrooms at all levels, grades one through 12. With proper support, the development of reasoning, listening, and reading skills can start in the first year of a student's formal educational training. The proper attitudes toward studying and learning mathematics should be developed beginning with grade one. It is exceptionally important that we begin to generate computer literacy and the rudiments of computer programming with all our students. Let me hasten to say that pouring money into education does not guarantee excellence. Our expenditures must be carefully considered and indiscriminant and wasteful spending avoided.

I shall use the Resolution on Technological Innovation proposed by the National Governor's Association Task Force on Technological Innovation as an example of an **ineffective** strategy for achieving excellence in mathematics education. This task force was co-chaired by Governor Brown of California and Governor Milliken of Michigan and was adopted at the National Governors' Conference in February 1982. In stated, in part, that:

> "Be it resolved that the states and the federal government join with business, labor, and academic leaders to:
>
> 1. Channel capital investment toward technological innovation and transformation of our economic base;
> 2. Demand excellence in math, science and engineering, and computer sciences in our schools and universities; and
> 3. Provide sufficient vocational education and on-the-job training for the new jobs in micro-electronics, computers, robotics, telecommunications and biotechnology."

The key term used by the authors of this resolution, as passed by the States' governors, is "Demand." It must be noted that according to this resolution, they will "assist" technological innovation by channeling capital investment in the proper direction, they will "provide" sufficient vocational education and on-the-job training to assist the high technology industries, but they will "demand" excellence in math, science, engineering, and computer education.

Certainly this is a most naive approach to solving the problems that exist in achieving excellence in mathematics and science education. While it is most easy to "demand," it does nothing toward a solution. In fact, such a demand, with no assistance to the profession for implementation, is probably detrimental.

In summary, in my testimony to you here this morning, I have called for the following:

1. A national commitment to the training of mathematics teachers, on a level at least equal to what was done through the National Science Foundation in the late 50s and early 60s;

2. An end to the practice of staffing mathematics classrooms with the overstaffing from other subject areas;

3. Placing mathematics specialists and mathematics teachers in our elementary school classrooms as well as in the secondary classrooms;

4. A commitment on the part of teachers to professional organizations and continuing education;

5. The dedication of teachers to the improvement of mathematics education;

6. Differential pay for teachers who are in short supply;

7. An end to social promotions;

8. A major upgrading of academic standards;

9. A change in compulsory education laws;

10. Legislation to allow for the enforcement of standards of student behavior;

11. A national financial commitment to education through state and federal governments; and

12. A national philosophic commitment to free public education opportunities for all who live in the United States.

It has indeed been an honor for me to appear before you this morning. I thank you for your kind attention.

DR. SEABORG: Thank you very much.

Before we start our break, I would like to say how pleased we are that so many of you have elected to spend this time with us, including the representatives of the news media. And we hope that you will be able to stay with us throughout the day to help us consider this issue that is so important to the future of our country.

We are now going to take a break and, even though we are running behind schedule, I would like to suggest that we take the full 15 minutes. On the other hand, also try to get back here at the end of the 15 minutes.

(Short recess.)

DR. SEABORG: Let's get started again.

We have with us now David Gardner, who is the Chairman of the full Commission.

David, would you like to say a few words? Not too long, we don't have that much time.

DR. GARDNER: That is easily responded to. I am pleased to say how appreciative I am of the efforts you have expended in anticipation of this hearing and your willingness to chair it.

And to all Members of the Commission throughout the country who could be here, we are very grateful indeed. Also to those who testified this morning, those who will testify later today, we are enourmously grateful for your help, your advice and your perspective. We welcome it and appreciate it.

And also advise you that very strong headwinds are blowing east from Salt Lake which accounts for the lateness of my arrival.

And we appreciate also the courtesies President Kennedy and Dean Atkin have shown the Commission in connection with our hearings today.

This is the first in a series of six public hearings. And I believe everyone knows the schedule between now and the fall.

Any of you who are participants, those of you who are here as observers, any of you who are here to testify, and members of the media as well, if you have any suggestions for ways in which the format of this hearing could be improved, we would welcome those suggestions and hope to benefit from them with respect to the scheduling and format in the future hearings.

Glenn, **thank** you for the opportunity to extend my welcome and appreciation.

DR. SEABORG: Thank you.

Now we have 50 minutes for an interactive discussion between the Members of the Commission, the panel on science, mathematics and technology education that is here today, and the panelists who have spoken this morning.

May I begin by asking if there are any members of the Commission who would like to make any comments or ask any questions of the panel?

Governor Quie?

GOVERNOR QUIE: I would like to ask Mr. Oliver, being a member of the school board for such a long time, how would the proposal of Mr. Taylor work out in your experience of having differential pay, as I understand it?

In most businesses, if you wanted to get somebody in there, you would pay enough to bring him there. It depends on how important it is. You keep on increasing the offer until you secure that person.

Now there seems to be such a standardization of pay based on how many hours of time and study, rather than having a differential in what one doesn't and does pay.

DR. OLIVER: I would say from my experience that it would be a very traumatic process to get such a concept across. I think it would take a great deal of discussion and long argumentation.

But it is certainly possible to achieve that, if it is necessary. It is happening now in our university system in the engineering staff who have achieved differential in pay. And that will extend down to the state universities as well.

I think the laws of supply and demand are going to function in spite of all attempts to suppress them. In the end they will prevail.

GOVERNOR QUIE: When you suggest, Mr. Taylor, that to English teachers, do they agree with you?

DR. TAYLOR: To be honest with you, I haven't said this to an English teacher. I do suggest, however, that there probably will be some trauma, probably in some places more than others.

But two weeks ago in Washington, D. C., I spoke with a representative from the Houston district and they indicated that they initiated this process last year and that they paid an $800 differential for a year to mathematics teachers.

And it was indicated to me that they intend to extend that to $2,000 next year.

GOVERNOR QUIE: Do they have their ---

DR. TAYLOR: They also indicated that they have no problems, no real difficulties in initiating this program.

GOVERNOR QUIE: Do they have collective bargaining in that school?

DR. TAYLOR: I really don't know.

GOVERNOR QUIE: All right.

M[illegible] FOSTER: Right, I think I can address that. I believe they have collective bargaining, but this national right-to-work is there as a state law. It does have an effect on them.

GOVERNOR QUIE: Well, I like your idea.

DR. OLIVER: I would like to add to my previous comment that I favor higher salaries generally to teachers, not just in the science and mathematics departments.

I think the teaching profession is very much underpaid and a very great many of our problems are the result of that.

This is a thing that only pays off in the long run because it really works by attracting better people generally to the teaching profession and raising the general standard of competence.

And it is a very difficult thing to sell to most communities.

MS. LARSEN: Dr. Seaborg, we have drawn a broad spectrum of input from our five experts this morning which has been most enlightening.

We have certainly gone from some of the despair and the indictment of public education in a few of the comments made by Mr. Oliver to the constructive suggestions by Mr. Taylor as far as trying to resolve some of the problems that were identified in our earlier testimony.

I know that those of us who are strongly supportive of public education, and I believe this Commission is, are extremely committed to the fact that a literate society is a free society and that is our goal for the future. We must see that public education is a quality education.

We do know that the schools have become the whipping boy for everyone's frustrations and we have been asked to be all things to all people.

The mandates for social change that have been placed on our institutions have been enormous, and we must address this and look for some constructive resolve.

I feel without a doubt that the focus of interest from coast to coast is on this issue at this point in time and that people collectively want to work together on this.

One issue that came out that I think the Commission has not specifically addressed, and I think perhaps we should fact it in some of our future deliberations, is that of the personal responsibility of the student.

We always talk about how the teacher must teach the student to learn. But we don't really identify that there is a need for personal responsibility and a commitment by the students to be involved and to be the captains of their ships, so to speak.

And I think going into citizenship, their character education, or whatever we would like to call it, that is the component that we need to further address.

The other day when we were coming back from a Commission meeting in Washington, D. C., we were talking about the elementary type of education that is at the science level.

And perhaps, Ms. Klein or Mr. Taylor -- your knowledge is somewhat in the elementary level -- is the shoebox type of science program or the elementary type of involvement of students in science, is that antiquated and out of date at this point in time. Or could their interest be generated by some of this new equipment? We talk about broken equipment and funding needs for equipment are

Could we use some of the more primitive types of equipment that we used to have?

Ms. Klein or Mr. Taylor, do either of you wish to respond?

MS. KLEIN: I would be glad to talk to that for just a couple of minutes.

I do not think that that is antiquated. The thing that I feel we really need to do is to give the elementary teachers the confidence that they have the knowledge to do this kind of science.

The other thing we must do is to try to give them some kind of help with regard to the time in setting up equipment, getting materials and this sort of thing, to bring those things into the classroom.

An elementary teacher has only so much time during the day to teach all subjects. This is why I feel that the consultant in an elementary school is a good person to have because that person can become responsible for seeing that the equipment and everything else is ready for the elementary teacher.

She acts, or he acts, as a clearinghouse for questions that need to be answered. It would be the blue blanket, if you want to call it that, for that elementary teacher in the field of science.

Most elementary teachers are not prepared in the field of science. Mathematics yes, because mathematics is considered to be a basic. Reading and language are basics. But science is not considered a basic.

Some of the best reading material, some of the high interest reading material, is in the field of science. It really should be included as basic and should be included as relevant for this elementary teacher.

Back to the equipment part. I do not think that these are out-of-date or antiquated, but they must be looked at from the standpoint of what we want that child to learn. Is it relevant to that particular experience? And I think that if we were to investigate and see how many boxes are there that haven't been touched in five years. If it hasn't been used in five years the chances are it won't be used in the next five unless somebody takes a look at it and says yes, it can be used.

But too many teachers use that as an excuse. And some of the best learning that is done is done through broken equipment and equipment that has to be put together.

MS. LARSEN: Perhaps it would be better for us to look at the structure of the elementary school day and have the ---

MS. KLEIN: Yes.

MS. LARSEN: --- curriculum taught by the classroom teacher and restrict the specialized study types of pull-out programs for the science program.

MS. KLEIN: I think that is very possible.

MS. LARSEN: Thank you.

DR. SEABORG: Yes, Mr. Foster?

MR. FOSTER: Professor Alder, I am looking at your speech, your recommendations. And you are proposing a rather substantial inservice training and retraining program.

This sounds like a rather -- well, let me start again. In the light of the urgency that we feel, all of us feel, about doing something about this, how responsive is this proposal of yours? How long would it take to put this in place, to get this thing done across the country where it is so badly needed? What would it take to do that?

DR. ADLER: Of course, it depends whether you have in mind a federal program or one conducted by the states. I am not sure that you are aware that many states are giving serious consideration to do such a thing within their state. Governor Brown in the State of California, in state of the state address, has proposed special funding for science and mathematics. Under such a program, such institutes might be one of the possibilities. I cannot give you a precise estimate of how long it would take to do this on a national basis. But there is a lot of experience there. I do not think it would take very long to do it.

MR. FOSTER: Did you want to ---

MS. KLEIN: I just want to concur with that. I think that the mechanisms are there. I think that we just need some place that says go ahead. I think the studies are there, we don't have to reinvent that wheel.

MR. FOSTER: Thank you very much.

DR. SEABORG: Mr. Sommer?

MR. SOMMER: Mr. Oliver, you gave public education a pretty bad report card. You compared some of the things with the Soviet Union. Are you fairly well acquainted with the total picture of the education in the Soviet Union, or are your few visits -- I don't know how many you had-- the criteria by which you plug the statistics that we are reading in our newspapers?

DR. OLIVER: Well, I don't pose as an expert on education in the Soviet Union. But I did see many classrooms in the course of this particular visit. And I also visited the universities and saw the quality of education that was going on there.

They had very poor equipment, but the things that they were studying were certainly not elementary by any stretch of the imagination. There was an air of concentration in the classrooms everywhere I went that was rather interesting to see.

And education there appeared to be much more of a sought-after thing by the students themselves. It was considered a great privilege to be able to attend Moscow University, for example. And you didn't find the negative attitudes that are ---

MR. SOMMER: You may ---

DR. OLIVER: --- in our own universities and our own schools.

MR. SOMMER: You realize why that was such a privilege, don't you?

DR. OLIVER: Oh, yes.

MR. SOMMER: Because of a very small percentage of ---

DR. OLIVER: That is correct. On the other hand, I was interested in the remarks that were made earlier about the possibility of abandoning the idea of compulsory education.

I think the opportunity for education should be compulsory. In other words, no student should be denied the opportunity to attend school.

But the idea of forcing a student against his will or her will to attend so many years converts, I think psychologically, what should be a privilege into an obligation. And I think that is the wrong thing to do.

MR. SOMMER: One more question. I would like you to tell me whether you really think that the voucher system would be a solution to our problem, in view of the fact that

I believe that public education is the very foundation of our democracy?

You mentioned something about that.

DR. OLIVER: I certainly think the public education has a vital role to play in our democracy. I am not advocating its overthrow. I think one of the consequences of the voucher system would be a competition between public and private education that would be more evident than it is today.

But I am not necessarily in favor of the voucher system for the reasons I indicated. I think there are problems attending it. And unless those can be answered satisfactorily, I would not be in favor of going that way.

MR. SOMMER: One final question. I have a feeling that we are going to best achieve our goal in improving education if our assessment is not the type that is McCarthy-like in nature. Because after the McCarthy hearings, we had to find Communists, and we finally did.

I am afraid that we are going to have to conclude that everything is so bad in our educational system that we have to find an alternate, a completely alternate system.

Do you think things are really as bad as one reads in the newspapers? Because I think that would be a very important matter if we assess it properly. Is it that bad? Or is it a matter of fact that education is very dynamic and there are constantly changes going on in our society -- reevaluation, is that what is basically at hand?

Or have we fallen behind so badly?

DR. OLIVER: Well, as I tried to indicate at the outset, education is not a homogeneous scene by any means. There are bright spots in the educational picture, and there are very sad spots in the education picture. There are good teachers and there are porr teachers. And there are well-run districts and there are poorly-run districts. You can find almost anything you are seeking.

And I think that the newspapers or the media in general like to find trouble rather than things that are running well. So those tend to be featured.

On the other hand, I don't think that we can be comp;acent about our national scores in many subjects. I think that those are an overall indicator that show we have work to do.

I further believe that we will never be satisfied with education. There will always be criticism of it, no matter how good it is.

But I do really believe that we are not doing as good a job as we should be doing, particularly in the field that you are concerned with. And there is need for improvement.

I was accused earlier of issuing an indictment of education. I think I certainly was critical. But I would also like to make some positive suggestions.

I believe that the villain in the piece is not the teacher, so much -- or our system, so much as the material that she or he is asked to present.

I believe that the criticism that I have, and the most important criticism I might make of math teaching in particular is that it is too abstract. An already abstract subject has been made more abstract in the new math. It has been further removed from the personal experience of the child.

And the cry for relevance that developed I think was partly due to this. What are we learning all this stuff for, the students asked. It doesn't relate at all to our lives. And I think unless subjects do relate to the life of a student, unless by learning them the student immediately feels more aware and more competent and enriched, the whole motivation disappears.

There has to be a translation of the work of learning into a feeling of a larger individual, a more knowledgeable individual, that makes the educational process worthwhile.

You don't, in my opinion, motivate learning by phony rewards. The remard for learning is the learning itself, that which is appreciated as being valuable by the student.

So subjects have to build on the child's knowledge that he has to start with.

MR. SOMMER: Mr. Chairman, could I ask another one?

DR. SEABORG: Yes, go ahead.

MR. SOMMER: I was wondering -- this is to the entire panel -- whether you believe that there are some serious signs that other basic skills, such as reading, are a very strong interference -- the lack of good basic reading-- in the science and mathematics program?

DR. TAYLOR: May I respond? I find that to be a very serious hindrance in my endeavor to teach mathematics to high school students. They do have a serious deficiency in their ability to read.

But even more important that that, they have a very serious deficiency in their ability to reason. They not only have difficulty with the comprehension of the written material, but their ability to reason is definitely not developed to the extent that it should be.

One other item I would like to put in there that is probably more important than reading is their listening skills. They simply cannot listen. And it is not a matter they don't. It is matter that they simply do not know how to listen. They do not hear.

MR. SOMMER: Thank you.

DR. SEABORG: Shirley?

MS. GORDON: I would like to ask you, Dr. Taylor, if you would be willing to respond to the comments regarding the mathematics instruction made by Mr. Oliver?

DR. TAYLOR: With regard to the new math?

MS. GORDON: With regard to the new math and the abstract nature of it, and so on?

DR. TAYLOR: All right. You will correct me. Dr. Oliver, if I have misspoken. I thought you said earlier in your statement that you felt a great of our problem today in mathematics education relates back to the new math.

And I would like to say that I agree with you on that. I do, however, suspect that we agree on the same thing for different reasons.

I do not necessarily believe that our difficulty with nre math was the abstract -- that was part of it, but it really was not the major problem.

The major problem we had with new math was the fact that teachers did not understand what it was all about. They did not understand the goals, the concepts involved actually.

And many, many students then were misdirected. They were poorly taught. And this especially happened in the elementary grades.

There was a feeling among elementary teachers throughout this nation that new math meant that you don't have to do anymore drill and practice. All you worry about is just the abstract part of the mathematics.

And I never understood new math to be that way, although that misunderstanding was there and that misunderstanding led to what we see today.

Perhaps Henry Adler would like to add something to that?

DR. ADLER: No, I am in substantial agreement with the major trouble of the new math having been such a substantial change in the curriculum that it requires well-prepared teachers. And that part of the process was neglected.

I really think that is somewhat a misconception of the new math, that it was its primary purpose to emphasize as you suggested sets and intersection and union. That really was not the main feature of it. I think it has been misunderstood.

And I think the lesson to be drawn from this in any future curriculum changes is that it is most important to not neglect the proper preparation of the teachers to teach the curriculum.

DR. SEABORG: David?

DR. GARDNER: Mr. Chairman, I believe Mr. Stever is trying to get your eye. And perhaps after his comment, I might have some questions.

DR. STEVER: Yes, I would like to put a couple of these comments together. I notice in the fact sheet that the Commission is to spearhead a major campaign to encourage all of America's schools, colleges and universities to enhance excellence in education. And somehow every time we get a problem, it falls on the high schools and the problems of the schools.

But the colleges have immense responsibility here. And I would go even beyond that. I would like to see you encourage all of America's schools, colleges and universities and those organizations who use and come in contact with the product of the students, to get behind this.

There was a question about reading capability -- how it relates to teaching of mathematics or science. That goes far beyond the teaching of mathematics and science.

A great number of complaints of the uses of engineers particularly and scientists to some extent -- scientists are a little isolated -- is that while they know their engineering very well, their capability of communicating is not good enough. Now around here we happen to have a fellow who can communicate very, very well. But a lot of them can't. And I think you should aim at that total system once you get this going here.

And, for example, I think that the college community, the university community, came on like gangbusters after

Sputnik, and did some things right and did some things wrong. And they did some things half right, half wrong, if we believe what we hear.

I think we have to get a system by which the universities and colleges and their scientists and engineers stay closer to the total education system. And I believe one of the jobs the Commission has is to point out that this is a totality and not some isolated thing you are going to have to work on.

DR. SEABORG: All right, Dave?

DR. GARDNER: The comment, Mr. Chairman, of Dr. Stever leads right into the question I have.

We have heard this morning with respect to the adverse outcome of a science and mathematics education in terms of this assessment of the performance of students in the last 10 years.

We have learned something about the nature of the problem in the classroom and the constraints and encumbrances associated with teaching math ans science.

We have been acquainted with the significance of students not studying these courses at levels and with a measure of intensity that permits them to open doors with respect to their own careers. Indeed, tends to close them.

We have had comments with respect to the importance of the universities and colleges interacting in the schools and the reverse, so that that relationship can be mutually benefitting.

And we have heard some comments with respect to the role of government. We also understand -- if I properly read these testimonies and heard you correctly -- that there is a significant implication for the country if the present trends persisting are not reversed as regards our international economic and political position, as well as perhaps our military security.

Now there is quite a debate at work in the country today as to the role of states and as to the role of the federal government with respect to education. Whose responsibility is it, is the question.

And different people answer that question differently. I would appreciate any mamber of the panel, or all five, sharing with us their view as to the division of labor between 16,000 school districts that comprise the educational system in this country, the 300 universities and colleges that exist, the state school boards, state government and the federal government and all the agencies associated with the federal government who have expressed an interest in this field.

That debate is going to be raging throughout the life of this Commission. It will be coming up, I believe, at every hearing we have. And I would very much appreciate your counsel and your insight on that question.

DR. SEABORG: Guy?

DR. STEVER: Let me start out and shoot from the hip while they are doing some serious thinking.

I think that is a terribly important question. It was magnified by a statement of one of the panelists who expressed the dismay the school teachers have with respect to seeing one of their big friends in government, the National Science Foundation, back away from science education the way they have. And they mentioned the teacher institute in particular.

And, of course, we do have a major new social shift and that is the new federalism and the shift away from the federal government. And maybe that is right.

But I believe that whatever substitute we get for it, we must have some centers where the professionals who are engaged in this business feel that there is something bigger -- they are part of something bigger. They are part of a big and important profession.

For the engineers and scientists who are in the universities and in the inductry, there are many centers that are very powerful that they work with and their professionalism is advanced.

Of course, the high school teachers, the teachers of mathematics, have their groups too. But they are not as well connected to the power centers as they should be. And I don't think that they can become without some help.

These spiritual centers, the professional centers, the things that get people together, are the organizations that really set the standards and pound on the rest of society to get the financial support. And that I think is a thing that is going to be missing as one of the key elements.

If you look at my microscopic suggestion there -- and I was only struggling for one approach which might bring a new way to get the teachers in the elementary and secondary schools in contact with the power structure of our society.

In that case, I proposed the industries. But this is the missing link in the new ideas. And we have got to get something to replace it.

DR. OLIVER: I don't know about the quality of our concept of national involvement in education. But I have concern that politics that arise and practices that may arise because of these powerful organizations may be not addressing the problems that really exist.

And I think that it should be encumbent upon anybody in a state or national organization concerned with education to spend a good fraction of the time in the classroom seeing what actually goes on, assessing the education at the point of delivery rather than inventing theories that may or may not have bearing on the problem.

DR. STEVER: Here, here.

DR. ADLER: I personally believe that no matter how this question is addressed, certain initiatives need to be guided at the federal level.

It seems to me highly inefficient, for example -- just to take the example of the institutes of which one member of your Commission asked me a question earlier. If each of the states independently initiates the methodologies and procedures around them, it is going to be it seems to me much more costly than having at least national guidance on how to do this.

Also, I think, on curricular rules, as I indicated in my testimony, national guidance seems to me highly desirable.

The only other comment I would like to make, as I indicated earlier, I would strongly subscribe to having bonds of college faculties in all subject areas with their counterparts in precollege education.

This I think is one of the big defects resulting from the discontinuance of the NSF institutes. There was a close liaison built up between precollege education and education at the college level.

I hope we can find some ways to reestablish this.

There are some signs that it is starting to happen at the local level. And I think while I have the floor, let me urge in this connection that the Commission look for models of types of successful endeavors which have occurred.

Mr. Sommer asked a little while ago how bad education really is in this country. To put it very briefly, I think there are a lot of good things going on. But too few people know about them.

I think the Commission has the opportunity to highlight such models.

MS. KLEIN: I think I can concur heartily with the thing Dr. Alder has just said.

The other thing that I would like to point out is with regard to the National Science Foundation programs. You know, there has been a tremendous amount of criticism about how difficult some of those curricula were.

And I would just like to remind everybody that at the middle school level I had goals to shoot for, knowing what I had to teach youngsters, knowing that they had specific things that they needed to know before they got to BSCS Biology or Chemistry, or whatever the course was at the high school level.

I knew that my students needed to be prepared to go into that. The ones that didn't have to go into that, fine, that was all right. Because there were plenty of other things there for them to gain from it.

But it gave me a goal of excellence, in order to try to attain that goal for the students that were in my classes. It gave me a reason to teach spelling, it gave me a reason to teach sentence structure, if I needed to.

Science really is a systemized way of learning, or a planned way of learning. Some days my courses look more like an art class. Some days they look more like a reading class. It depends upon what had to be done.

But the curriculum gave us excellence to teach to.

Now, the other thing that I would like to point out with regard to these curricula, the BSCS curricula, it was very interesting in our research that we had just completed when we found out that -- and I am going back to the written testimony that was presented, on page 6 where we stated that:

> "According to preliminary results of a very recent study, the new curricula were far more successful than most people realized. In this NSF-support project, directed by Ronald Anderson and Jim Shymansky, an analysis was made of 105 studies involving 45,000 students.
>
> "Comparisons were made between students enrolled in new science

> curricula and traditional curricula. On every kind of measure, including achievement, attitude process skills, students taking the new NSF curricula scored overall 13 percent higher.
>
> "For the BSCS Biology and Chem Study materials, the students scored higher by more than 17 percent."

Now this is the clincher:

> "What is most significant is the fact that students from low socio-economic groups scored 24 percent higher using the new NSF-supported curricula than traditional curricula. Thus, since larger proportions of our minority population are in the low socio-economic categories, the new curricula supported by NSF gave minority children a decided edge over similar children exposed to traditional materials."

I would just like to verify that from experience. I felt that those youngsters that I worked with, even though I was in the middle school level, better prepared than the students that I am working with today because there doesn't seem to be a standard of excellence to teach to.

And I would heartily support the things that Dr. Alder has suggested.

DR. OLIVER: May I ask whether the test that you are quoting the scores on was addressed to the new materials or the old?

In other words, if you teach two groups and give them this test -- teach one by one method and the other by another method -- then they are going to do best in the test that is addressed to the way they you were taught.

MS. KLEIN: I can't answer that. I just know that my classes most of the time that I have been teaching, have been hetergeneous classes and not homogeneous classes.

DR. OLIVER: Well, you understand my point?

MS. KLEIN: I understand the point.

DR. OLIVER: One method covers certain materials and another method covers other materials.

MS. KLEIN: That is exactly right. And it depends on whether you are teaching for processes and skills or whether you are teaching for content.

And I maintain that at the high school level it should be approximately 90 percent content. Whereas, at the spot that I am in, it is about 50-50. At the elementary level you are teaching for maybe 10 percent content and 90 percent basic skills.

Dr. Glen Burkheimer has just completed a study on that. And I think that it would be interesting for you to get a copy of that study to show where process should be taught and where content should be taught.

And I concur heartily that we can always test for what you want the test results to show.

MS. LARSEN: I believe it was Dr. Alder whose testimony stated that the top students are on a par with where the top students were a generation ago. They have not declined.

But it was the great middle group that were falling so far behind.

Now, in the last generation public schools have ceased to use the tracking type of philosophy. They have felt that there is must to be gained by having a broad spectrum of students within each class.

That therefore teachers' expectations of students should be uniform and students should be able to perform adequately.

Do we need to look at that again and perhaps direct students according to their potential or to their particular tendencies, using aptitude tests, et cetera? Is that something we should review again?

Dr. Alder, do you want to speak to it? Or anyone else?

DR. ALDER: Maybe I should defer to somebody else.

As you can presumably detect from my accent, I didn't go to school in this country. Maybe somebody else can answer that.

DR. TAYLOR: I would like to respond to that, as well as respond to the original question.

The answer to your question, Ms. Larsen, is, very briefly, yes. We definitely need to consider tracking students according to their ability. Very definitely.

With respect to the original question, I believe the task before the Commission is to carefully distinguish between what is perhaps philosophy and reality.

Philosophically, one may believe that all education problems should be solved at the local level and that neither state or federal governments should be involved.

But I think reality very clearly points out that the problems caused by failure to educate students in this country are not local problems alone. They are national problems, and for that reason must be addressed by the national government -- by the federal government.

And if that is the case, the the federal government and the state governments must be involved in solving those problems to see that our educational system stays on par with where we want it.

One other brief point. Pragmatically speaking, at least in California, our tax base has -- for supporting education locally -- been removed from us. We have no way of raising the money through taxes to support our local schools. We simply have to go to the state for that.

And if that is the case, I am sure that the state can say the same thing -- that they are unable to raise enough money through taxes to support their state's educational system and must look to the federal government.

As constitutional decisions are made, such as, local property taxes are no longer constitutional in California for supporting local educational systems, our tax base is removed from us and someone elese simply with the authority to raise taxes must support us.

GOVERNOR QUIE: I would like to make one comment. Right now I am a little troubled by the federal government's involvement and I hoped that some way or other there would be a federal solution to our problem. Because in the years that I spent in Congress we went from very little federal help in education to where it is now.

So if the federal government is going to help, it seems to me it would have helped by now.

Secondly, it is the National Science Foundation that has changed this whole relationship with the secondary schools -- and even the undergraduate sshools.

And that change began before this present administration came to office. And I always thought that the

National Science Foundation probably set up the proper way, because it is more direction by peers than some of the other federal agencies.

So I have got a little trouble waiting for that President who is going to solve it all for us, or that Congress that is going to solve it all for us. All those characters come from the same place.

I like to think of the federal government bringing a correctness. But it still comes back to the people who are responsible in the field.

And if I was going to lay a finger on one group of people that have to break this cycle that we are in, it would be the people who are involved in the institutions of higher education. Because that is where you are training teachers of the future. That is where you set the standards for students that you track out of the elementary and secondary schools.

I believe instead of federal solutions, what we are talking about is setting some national policies and then I would hope that the institutions of higher education would be strengthened to address themselves to the improvement of science and math teaching.

Because that is where I think you could do something about it.

DR. SEABORG: Jay?

MR. SOMMER: How about having the dynamics and methods changed in view of the computer sciences and all of the new things that have come into science?

Is it possible that we have to evaluate methods in science teaching completely? I know for example that in my own area, foreign language study, the methods are quite loose and there is no uniformity. And I think that is one of the problems of foreign language study.

How does that apply in the sciences?

MS. KLEIN: I don't see how anyone can teach science unless you have taught home economics.

(Laughter.)

MS. KLEIN: Now that really sounds very ludicrous. But every year that I ever taught home economics, I always had to teach one science class. They would say, oh, we see you are certified in science. Well, we just happen to have a chemistry class, well, we just happen to have a biology class or a senior health class.

And do you know, those methods for organizing materials, those methods for putting everything together, just fell in place whether it was biology, chemistry, general science.

And I even was foolish enough at one time to think that I might even be able to teach a math class because some of my kids didn't understand math and I said I am going to apply these same things.

What is the problem? How do I go about it? And organize it from that standpoint. I can't answer for anyone else, but I just know that one has to be well organized in one's own mind before one can approach a student.

And I just feel that someplace along these 27 years of teaching, I read a statistic saying that teachers reach their peak at about the seventh year that they have taught. And I can heartily agree with that because those first six years you are trying to live with yourself.

And about the seventh or eighth year you think well, it wasn't too bad after all. I believe I can manage most anything. And you feel pretty complacent. And all of a sudden you meet that youngster that says you don't know it all, and you have to go back and you have to rethink, relearn and start in all over going with new methods.

And you have to be convinced yourself that you can work with youngsters. And you have to feel some degree of success yourself. I don't know that there is a methods course that has been written that could apply to everyone.

MR. SOMMER: Well, I didn't really mean to everyone. But I was hoping that there was something a little more specific because I suspect that the colleges will narrow down even further the teacher preparation programs. And they will say, well, now we discover that it doesn't matter what subject you are teaching as long as you know class management.

And I tend to believe that that wouldn't be the case.

MS. KLEIN: No, that wouldn't be the case.

DR. SEABORG: Well, maybe as one last question -- perhaps a touchy one but it may evoke a lively response. It has to do with the length of the school day.

I learned from the news media just the other day that California seems to have one of the shortest school days in the nation.

Does anybody have any thoughts on that?

DR. TAYLOR: I would like to respond to that. I don't know whether what you are saying is true about the length of the day in California. But I do know there is legislation either pending or about to be introduced in the legislature to lengthen the school day in California.

It has been suggested by Mayor Bradley of Los Angeles that perhaps if we lengthen the school day, we can keep the kids in school. That way they won't go home and watch television and we can break their addiction to television that way.

If that is the purpose of lengthening the school day, I suspect we had better not.

DR. SEABORG: No, I don't think that would be the reason.

DR. TAYLOR: My serious comment is, in my mind there is no question that teacher contact with students improves their learning. And if you are going to give me more time with the student, I can enhance their learning.

And in that respect, I would certainly be in favor of a longer school day so that I could have more minutes with the students.

DR. SEABORG: Sarah?

MS. KLEIN: I was just going to say that I don't know that it's the length of the day that makes the difference. Again, it is the contact with the student.

Someone on the panel mentioned the fact that teachers were doing so many other things with students now that schools have become a total social agency rather than a learning institution.

And I believe that we really need to address this fact also, that we must make schools a learning institution instead of all of the social functions that go on.

So, if we can have X-number of minutes with that student, fine. But not interrupted. And try to get some sort of -- again, we mentioned listening skills because they are literally trained for a commercial break.

They have listening skills that last for maybe seven minutes, and then a minute and a half for commercials, the seven more minutes and a minute and a half of commercial, within a fifteen minute span or a half-hour span.

And so you plan your class program so that you have that break, and then more concentration, a break and then more concentration. I have learned to group and regroup over the years many times depending upon the media of the moment, and depending upon the thrust of the times.

And in Connecticut, there was a mandate that we must have some guidelines in 11 field areas, 11 subject areas, to be instituted if the communities needed them by the fall of 1981. And I was fortunate, or unfortunate as the case may be, to work on that set of guidelines.

And one of the areas we looked at was length of time -- maybe you would like to look at that study that we did for science. And I know math was the same thing.

And I think it is direct contact with the students that is important.

DR. SEABORG: Bernie?

DR. OLIVER: There is some evidence that the length of the day doesn't matter. I don't know whether to believe the evidence or not.

During the baby boom, many California schools had to go to double session. The results of tests there seemed to indicate that students on double sessions did just as well as students that were not on double sessions.

On the other hand, there were several things that each student would learn, whether it be double session or not. And there may very well have been less learning in the double sessions students, even though the tests indicated higher scores. So one would really have to study that with care.

My own feeling about the length of the school day is that it shouldn't be so long as to not give the teacher time to do adequate preparation and correction of papers and all the other things that must attend the educational process.

DR. SEABORG: All right, I think that if we are going to reconvene at 1 o'clock, which is the plan, we probabaly should break now.

I had mentioned earlier that I was going to announce the individuals who will have an opportunity to testify beginning at 4 p.m. Each individual will have five minutes to make a statement and that will take us to the end of the day.

I will have more to say about the earlier part of the afternoon right after lunch. The record will remain open until April 11 and we welcome written testimony from all other interested individuals.

These are the 11 people who have indicated a desire to testify this afternoon:

Frank Oppenheimer
Leigh Burstein
Judy Chamberlain

Kathleen Hulbard

Ted Perry

Paul Hurd

Elizabeth Karplus

Louis Fein

Bob McFarland

Katherine Burt

Joe Hoffman

So that you for your attention. We will see you at 1 o'clock.

(Whereupon, at 12:05 p.m., the public hearing was recessed until 1 p.m.)

AFTERNOON SESSION

(1:05 p.m.)

DR. SEABORG: Shall we start?

Our agenda for this afternoon is very tight. We are going to have a rather complicated technological way of keeping people on schedule. I will try to explain that to you here.

There are 17 individuals who have been invited to present testimony on programs in which they are involved or on perspectives that have on the topics before us today.

Rather than announce the complete list now, I will introduce each person in the order listed on the agenda. I ask each of the people as they come up to make their presentation, to identify themselves and their connection.

Each person will have five to seven minutes in which to make a statement. An electronic device will begin to beep after five minutes to help us stay on schedule. And I would appreciate -- I assume each of those who are going to speak has a schedule -- I would appreciate it if the next two that are on schedule would come up and sit at the table as the person that is up there is speaking and sit there as the individual testifies.

We will then begin with Mr. John Martin, and then two more come up.

STATEMENT OF JOHN MARTIN, ASSISTANT SUPERINTENDENT
PALO ALTO UNIFIED SCHOOL DISTRICT

MR. MARTIN: Chairman Seaborg, Members of the Commission, ladies and gentlemen, I come to you from a school district that I believe to have a fairly enviable reputation for excellence in math and science education. The Palo Alto School District weathered the student storms of the sixties and is in the process of sttempting to weather the financial storm that followed the passage of Proposition 13.

Student enrollment in college-recommended science and mathematics courses and students' performance in college entrance examinations or achievement tests and SAT advance placement examinations continue to demonstrate the magic that results from a combination of a supportive community, a motivated and goal-oriented student population and a competent and dedicated teaching faculty.

Before making the move from this pointing with pride to a position of viewing with alarm, permit me to make a few additonal observations.

Palo Alto operates two high schools for the student population of about 3,500 students. Seven periods of instruction are available and the average student enrollment is in excess of six periods over the four years.

Historically, 85 percent of graduating seniors enroll for post-secondary educational opportunities, with 55 percent earning at least a bachelor's degree.

Currently -- and I think this will be of interest to you -- 72 percent of the 11th grade students in our two high schools are enrolled for Math III, with 66 percent for Math IV, with 26 percent of that latter number taking a calculus course and another 200 enrolled in Math 42, which is a computer programming course.

Of the juniors ans seniors currently enrolled in courses beyond the geometry, 45 percent are female. Of the 2628 grades 10 through 12, 80 percent are enrolled in college-recommended courses in laboratory science, biology, chemistry, geology or physics.

Three hundred and sixty-four of those students are enrolled in district-supported college level courses in physics, chemistry and biology. Of the 10th to 12th grade students currently enrolled in laboratory science courses, 44 percent are female.

The 10-year history of the college entrance examination course for Palo Alto students shows an increasing number of seniors in each class, some 60 to 70 percent over that period of time, and various achievement tests currently at about the 50 percent level, giving the arary of opportunities in that setting.

Although those proportionate test-takers are double the state and national average, the scores have consistently resisted the downward trend found in national scores. In fact, there has been a slight trend in the upward direction over this 10-year period, particularly when compared to national and state averages.

The two achievement scores which best demonstrate the level of mathematic and scientific achievement are Level II Math and Biology. The Level II Math test scores average for the class of 82' was 706. That was the average score, compared to the national average of 651.

The district's 10-year average on this test was 705, compared to a 10-year average nationally of 660.

There is additonal data on the performance of the students in the Palo Alto Unified School District on the college entrance examination board that I have included in the packet. And I will not take time on this occasion to speak to that.

I would just observe, however, that of the June 1982 graduates, the average checmistry score was 602 and the physics score 676. And we currently have 10 sections of physics on both high school campuses.

Of the 130 seniors who wrote AT examinations in calculus, 50 earned a score of -- 50 out of 130 --

96, a college credit producing score of between 3 and 5.

Comparable data for physics are 100, the number taking the test, 39 who got 5 and 96 percent who scored between 3 and 5.

For chemistry, the data are 30, 11 and 100 percent. For biology, 149, 57 and 89 percent.

Now for the other critical element in the chemistry of excellence in math and science education, the district's teaching faculty.

Of the 47 full-time high school math-science faculty, 43 have undergraduate majors in either math or science, 14 have earned master's degrees, masters of science degrees in the area of their instructional responsibilities -- I am not speaking of education degrees -- and three hold doctorates.

Forty-one of the faculty, 41 of those 47, have 90 or more units beyond the bachelor's degree, with the majority of these units in either science or mathematics.

Since Palo Alto not only attracted competent well-trained math-science faculty, but also succeeded in maintaining those teachers in its employ, its faculty has benefitted greatly from the NSF institutes that have been spoken to earlier today, both in mathematics and the various science retraining programs that were developed in the post-Sputnik era.

That retraining has continued. Granted the opportunities are far more limited. But I would like to observe that the most recent evidence of this is the fact that two of our science faculty are currently engaged in field testing and redesigning the materials in Basic Genetics: A Human Approach.

A highly motivated, goal oriented student body requires this quality of teaching faculty if the students are to achieve their aspirations. And now for the alarm....

The time is rapidly approaching when large numbers of the district's science and math faculties will be eligible for retirement. The average age of one high school math faculty is fifty-one. This fact -- coupled with the impression, if not the fact, that fewer and fewer bright, high-achieveing undergraduates in math and science aspire to teach -- gives testimony to the problem. Moreover, statutes governing the placement of tenured faculty who have been "surplussed" from the department of their major preparation and experience require the district to assign these teachers to openings in science and math for which they are "paper qualified" because they have a weak minor in math or science and a general secondary teaching credential. At the very best these faculty members can be expected to teach only the lowest level courses in math/science. No longer then, can any member of the high school math faculty teach any department offering from the pre-algebra to the Calculus. Increasingly, junior high math and science teachers are assigned to high school teaching vacancies in these departments -- an action that frequently depreciates the quality of instruction at both levels. Let there be no doubt, when the middle school math or science faculty demonstrates weak academic preparation, the quality of student performance at the high school level is bound to suffer.

Unless some things happen soon, the testimony received by groups like this in the 1990's will be different, and the difference will not be in the best interests of our citizenry. I believe the problem to be one of enormous proportions. In the words of one of the district's instructional supervisors of mathematics, ".... I predict an absolute disaster in the field of mathematics education in the near future unless drastic measures are taken."

While I don't know the extent of the actions which might be taken, I believe that a first step is to convince decision-makers of the gravity of the problem. I suspect that the ultimate solution to the problem will be costly. The opportunity to teach math and science in high school must be made more secure, more rewarding.

Only then will the talented undergraduate look favorably to teaching as a profession. The single sa[illegible] schedule may have outlived its usefulness. Indeed, the solution may well prove very costly, but failure to solve the problem is unaffordable. I suspect that quality college and university programs to train curricular and instructional leaders in math and science could be expected to follow, even though at the moment such programs are non-existent or -- at best -- in disarray.

I don't know the answer. I believe, however, that I have a feel for the problem. I welcome the opportunity to elicit the help of this Commission in verifying the problem and in addressing itself to its solution. I see little way that a single district, however successful, can respond effectively.

Ladies and gentlemen, I am sorry for having overshot my mark.

DR. SEABORG: No, that is all right. You have a minute or two after you hear the beep, which you used.

MR. MARTIN: Which I have used.

DR. SEABORG: All right, the next speaker is Ruth Willis. Introduce yourself and your connection.

STATEMENT OF RUTH WILLIS

HAMILTON JUNIOR HIGH SCHOOL, OAKLAND

MS. WILLIS: Thank you. My name is Ruth Willis and I am at Hamilton Junior High School in Oakland, California.

Let me tell you quickly something about my school. It is a seventh to ninth grade school. There are 1100 to 1250 students in the school. That is the difference from fall to spring enrollments.

The student body is 42 percent black, 35 percent Spanish surname and of the Spanish surname, roughly two-thirds of those students have been in this country five years and one-third are recent arrivals. Ten percent of the student body are Asian. Half of those are U. S. born and half recent immigrants, mostly Cambodians, Laotians, Indonese and Vietnamese.

The Asians that are U. S. born tend to be Chinese. We have few Filipinos. There is a boast that we have more Native Americans at our school than any school in California. I don't know if that is true, but it seems about 30 to 45 students -- and five percent white students and a smattering of other people.

The teaching staff is a direct reflection of the ethnicity of the students, with the exception that there seems to be a lack of Spanish-speaking women and a lack of black males. But in numbers, they are about the same proportion.

In addition, more than 80 percent of the student body come into Hamilton below grade level on national test scores.

The school has a history that is important, that I had better quickly mention. Twenty-five years ago it was a white middle-class, upper middle-class prep school. Today, obviously, it isn't.

Six years ago, the school was denounced by lots and lots of people in many, many areas for being a school where there were race riots and extortion and incompetent faculty.

There was a change of administration. The students after six years can actually go through a career program. And since that time, we are still stuck with a PR problem. It is typified by the fact that 60 or so identified sixth graders -- identified by the teachers as high potential -- were enrolled in Hamilton last spring and only eight or so showed up in the fall.

A positive look on that is that what also happened to us is that in previous years, parents who kept their students at Hamilton through the eighth grade program, when it was time to go to Algebra, we would typically lose ten students before they go to Algebra. They would go to other schools for high school.

An indication of success is that last year we lost only three.

On our staff, we have eight teachers teaching math at Hamilton. One has an undergraduate degree in mathematics, one has a minor in mathematics and two have had at least one course in math since they have left high school.

The rest of the teachers have no formal math training after high school. And I am afraid that that is typical of math teachers in junior high schools across the country.

A difference I think in Hamilton math teachers is that they have all taken advantage of inservice support. And a change has been that the teachers manage somehow to get enough energy and enough enjoyment to do what they want to do.

And those inservice supports that I know of, that people talk about, and will talk about more, are of three kinds.

One, curriculum support. Teachers need to know more about how to teach analysis. They need to know more about how to teach word problem skills, word problem-solving skills, statistics, probability, computer literacy. They need more support in mathematics.

A wholly-NFS-supported program was very important to a couple of teachers at our school. They just learned more about algebra and calculus.

And the other kind of support they need is in methodology. And the best way for them to get it is that the inservice be taught in a way that we would like to see them teach their students. So that they get a chance to participate in doing mathematics and not just have it poured down their throats.

And I know Nancy Kreinberg is here and will certainly speak to that.

The other kind of inservice in methodology that is very important is that someone come out to the classrooms to help teachers. There is a program, CCPT, that I am sure you will hear about at some point where teachers het support in their classrooms in watching each other teach and watching another teacher teaching.

Enough about the teachers.

The kind of problems and successes we have had: One of our successes is that our math teachers' typical day starts at 7:30 and ends at 5. And I don't know that teachers typically do that.

The other thing, we have a problem with boys in mathematics. The top of our seventh grade calss are boys due to regular sexism. The top of our ninth grade class are

are girls; possibly due to extraordinary sexism and racism, but we don't know.

But the thing that we have found that has made a difference is that we had mentors in. The boys could identify with the mentors. We have had after-school, before-school classes. And we have typically 45 students spending an extra hour after school voluntarily three days a week at Hamilton.

We created peer groups for the boys where mathematics is important, as well as for the girls.

And since my time is almost about up, I might stop except for one more thing.

The most important thing we had to do was to make sure that the students felt they were capable. And in order to feel that they are capable, it is important to give them lots and lots of praise for doing language, as well as mathematics.

And the result of that is that my students ask better questions, they ask questions like, "but how can I tell the degree of this polynomial if zero is a legitimate coefficient? I mean it could be hiding, zero times into the 15th somewhere."

That is important to me. And the way you get that to happen is, you do things like, "tell me how to add one-half and one-fourth. Explain it using the word numeric.

Explain it using the word numerator and denominator in a sentence that has at least 20 words. Write a paragraph about it."

"Describe to me how to draw a triangle. Turn it around, you can't tell me what to do. I just need the words."

And it builds up that precision and confidence -- and I am out of time.

DR. SEABORG: Thank you.

The next speaker is Sam Dederian. Because Mr. Dederian is representing several groups in San Francisco, he has been allotted 10 minutes.

STATEMENT OF SAM DEDERIAN

SCIENCE SPECIALIST

SAN FRANCISCO UNIFIED SCHOOL DISTRICT

MR. DEDERIAN: Wonderful.

I am Sam Dederian, the science specialist for the San Francisco Unified School District. I am going to describe to you two exemplary programs, one in science and one in mathematics.

And then what I was asked to do is give some personal reflections on teacher training in science and mathematics.

If you want to know something well, just try to teach it. Successful teaching not only requires knowledge, but the ability to analyze, to organize and to know your audience.

The science docent program at George Washington High School in San Francisco gives high school students the opportunity to learn and then to teach in an exciting and realistic environment.

The science docents are trained to teach elementary school children who visit the Strybring Arboretum in Golden Gate Park. The rich collection of living plants in an outdoor setting provides visitors with so many things to do that one must return several times. And the children do that.

The science docents conduct four different walks over the school year. The topics include seed dispersal, flowers, the redwood forest, native California plants, and this year they are going to begin a walk on endangered plant species.

Typically, the high school students spend about two weeks preparing for each of these walks. The read from a variety of resources, carry out laboratory activities and participate in discussions with their teacher and the professional staff from the Arboretum.

At the same time, the skills they need to present the information to the children are developed. Role playing is one of these useful techniques.

When they are ready, teams of docents go to the park during their lunch period and class period. Each docent leads a group of seven or eight children and, as they move about, points out features of plant adaptation, reproduction, ecological relationships and even uses by the Native American Indians.

Each walk takes about 50 minutes. And at other times, the high school students visit classrooms at one of the four elementary schools that participate in this project. And at that time, they present lessons or demonstrations which were not conventiently presented in the park.

When not preparing for or conducting lessons for the elementary school students, the docents are busily engaged with their teacher learning the biology and ecology of plants, preparing their own projects and discussing various aspects of plant ecology and environment in general with guest speakers.

This instructional level is high as this is considered to be a college-preparatory course. Initial funding for this program was provided for by the Environmental Education Fund of the State Department of Education. This program has been going on for about three years.

The science docent course is a combination of theory, practice and communication which is rarely allowed in high school students. Perhaps its most important benefit has been the development of interpersonal relationships.

We also have a mathematics program which was developed in our school district and has spread out throughout the state. And that old saying that "one is not a prophet in one's own home town" is absolutely true here. I think this program is more popular outside of San Francisco than it is in San Francisco.

But this year that has changed somewhat. The program is called Consumer Math in the Electronic Age -- very briefly called Calculator Math.

Over the years there has been heated discussion about placing calculators in the hands of students. A primary concern seems to have been the assumption that students would not develop skills for doing computation mentally. We all know, however, that the successful use of arithmetic in real life involves the ability to understand the problem, to select the appropriate operation and to estimate the result. Only then does one engage in computation.

Since the calculator performs the computation accurately, the student using one may be able to concentrate on the other operations.

It would be interesting to know if computational skills can be enhanced when a student performs the other operations with confidence.

The program was developed for the ninth grade arithmetic curriculum as a supplement. And the students, on the average of one period a week, use the calculator math program materials that have been developed.

Usually, about 15 calculators are all that is needed. And two students per calculator. The interaction of two students working on one calculator usually helps the learning process.

The lessons deal with the individual skills that are a part of the regular curriculum in a relatively consistent manner. Each operation is introduced with an instruction sheet which describes how the calculator can be used to carry out that particular operation.

This is followed by a work sheet on which the student is asked to estimate the answer before operating the calculator. Once that is finished, the student is directed to word problems using the same skills.

Finally, two tests are given, one where the calculator is used and one where it is not used.

The program has been evaluated quantitatively and qualitatively. Here are some of the findings.

In one evaluation of ninth graders, the pre-test and post-test scores for the experimental -- that is, the calculator-using group -- was two units. And for the control group, it was 1.2 units. That is an increase in both cases.

But the test -- and this is important -- the test for both groups was taken without the calculator.

In another study, again both groups not using the calculator, the low-grade level experimental population gained 2.1 years, and the control population gained 1.3 years.

This might help some teachers. Teachers reported that the attendance on those days that they used the calculators was higher than on those days when they used the traditional type mix.

Evaluators also observed that low ability students and girls -- that is not the same group, but two separate groups -- were motivated and interested in using the calculator.

They speculate that the instrument gave students confidence. And here is another remarkable thing. The teachers were receptive to the workshop training, and these were very well-experienced teachers who said, no, not another workshop. But they wanted to go to this workshop because they recognized they could use the material immediately.

The program adheres to the priorities developed by the National Council of Teachers of Mathematics in 1980. Those are:

1. Problem solving should be focus of school mathematics; and
2. Basic skills should be defined to encompass more computation facility; and finally
3. Mathematics programs should take full advantage of the power of calculators and computers at all levels.

Most of the work problems deal with real life situations and consumer situations, such as calculating food bills, electric bills, and so forth.

Students engage in mental arithmetic, estimation, rounding off with a problem-solving focus. Finally, the students are using a tool which will allow them to do more sophisticated computation more rapidly.

Now, what I have to say here are personal reflections. This is not a scientific report by any means. But bear with me.

It has been said at times that mathematics instruction in our schools does not adequately prepare students for collegiate training. Perhaps there are many reasons for this phenomenon.

I have chosen to characterize one factor -- the status of teacher training, and support it with a little bit of data from my own school district. No national studies here.

Perhaps what I have to say describes the situations in other school districts. I will leave that to the judgment of others.

There appears to be a need to develop in practicing acience and mathematics teachers the techniques which are effective. Closely following this is the need to reexamine the curriculum. And what we mean by curriculum is content and a process. That is, what is taught and how to teach it.

I believe, however, that the nature of the curriculum ultimately depends upon the quality and effectiveness of the teacher training effort.

The curriculum is a tool used by teachers to promote learning. What good is a tool if one doesn't know how to use it? The teachers, not the curriculum, do the teaching.

I suggest that our attention should be directed at the need for training practicing teachers. There is only one critical mass in education, and that is the teacher.

What that petson knows, how that person perceives his role and how that person refines his students' natural curiosity into the skills of inquiry and analysis will determine the outcome.

This nation has had some successfull experiences with the training of practicing science and mathematics teachers. The National Science Foundation curriculum projects and inservice institutes of the 1960s have had profound influence on teachers, text books and instructional materials and even laboratory facilities.

But the effect was transitory. For soon after the nurturing of a student is a process consuming several years, so too is the sustenance of a teacher.

Someone once described pre-service education courses as survival training. And I had to agree with that, that they are not sufficient to qualify the beginning teacher to confidently and effectively carry out his responsibilities over a teaching period of thirty years.

Our society -- if you don't believe me, read Alvin Toffler's Third Wave -- our society has been changing by decades not lifetimes. My colleagues and I have been one, two, three decades away from our respective schools' education.

School districts do indeed require the teachers to take college courses to qualify for higher salary classifications. But once the teacher has reached the top of his salary schedule, what incentive is there to continue training?

In the San Francisco school district, one need not accummulate any academic credits beyond the twelfth year. That is, if one is at the third level.

In a quick survey, the secondary school teachers with major degrees in science and mathematics -- and an interesting statistic appeared at the middle and high school levels -- 89 percent of the science teachers and 91 percent of the mathematics teachers have twelve or more years of seniority.

Dr. Seaborg, can I have two more minutes?

DR. SEABORG: All right.

MR. DEDERIAN: Thank you.

This does not imply that all teachers who have reached this level of seniority do not seek further training. They do. But considering the changes in our society in general, and changes in student populations in many schools, the need for more and extensive and continued training may be indicated.

The training ofmembers of the faculty should be a planned affair which supports the educational objectives of the school. If the school intends to establish a new process, many members of the faculty must undergo that same training experience.

There is no use in having one member of the faculty go to a workshop. A school should not be the result of an accidental collection of scholars.

May I suggest another factor which may inhibit the training of science and math teachers. College fees are particularly costly these days. Some teachers have taken on second jobs in summer employment to support their responsibilities.

Perhaps some teachers do not take courses because of the cost. I don't fault them. And the message I wanted to transmit is that the training of teachers is too important to leave to chance and the financial status of the individual.

I want to look at the age distribution of teachers in San Francisco. If you take the age of 55 years as a reference point, about 16 percent of our present teachers who majored in mathematics and about 20 percent of our present teachers who majored in science are within ten years of retirement.

However, at the other end of the spectrum, there are no mathematics majors younger than the age of 32, and only four who have science majors younger than the age of 32.

What will be the teachers, teachers who average about 47-48 years of age, what will be the schools when they become senior faculty members? Who will be the teachers entering the lower grades of the profession, what kind of training will they receive?

Now we come to the question of what the government can do to improve the schools. In the past, enormous amounts of money have been pumped into the schools from all levels of government.

All right, a promise is a promise.

DR. SEABORG: All right.

LeRoy Finkel.

STATEMENT OF LEROY FINKEL

SAN MATEO COUNTY OFFICE OF EDUCATION

MR. FINKEL: Thank you, Chairman Seaborg, Members of the Commission and members of the audience among whom I see a lot of friends.

I am LeRoy Finkel, Instructional Computing Coordinator for the San Mateo County Office of Education. I am a little bit uncomfortable I think because I spent my undergraduate years at Berkeley. And every time I step on this campus, I get a little nervous.

This report will describe the software evaluation, software dissemination, and inservice training services provided to schools by the Microcomputer Center of the San Mateo County Office of Education.

Our program differs somewhat from the other exemplary programs you will review in that we influence the educational development of students indirectly, by providing training and service to teachers and school administrators, some of which you have heard the need for earlier.

We are in full operation now. We have been for two years. Our entire operation has been funded to date from base program funds with no financial assistance from special state or federal programs.

We have three primary goals. The first of which is to train teachers and administrators in the use of computers so they can make sound plans and wise decisions regarding the purchase and use of computers in their classrooms.

A second goal is to tprovide and develop free and inexpensive classroom computer materials for teachers to use with children.

A third goal is to provide a resource where teachers can come to screen and evaluate classroom materials as they come out of the marketplace and to disseminate reviews of thse materials to a wide national audience.

The microcomputer center currently serves as a de facto prototype regional center for the State of California. The center was primarily designed to meet the educational needs of San Mateo County.

However, since we are the first and the most complete center in terms of staff, computer hardware, computer software and related resources, we have also acted as the regional center for many school districts outside our own county.

Most of the other offices in California that are planning to establish microcomputer centers like ours have visited our center as part of their planning.

Our central location in the San Francisco Bay Area near the Silicon Valley manufacturers has made us a very convenient visiting point. In addition, we have gained the reputation of having both an experienced and knowledgeable staff and a strong overall office commitment to the uses of microcomputers in education.

During our first two years of operation, we have had visitors from 35 California counties, 22 other states, three Canadian provinces and nine other foreign countries -- something over 1700 visitors.

Our office works very closely with a very unique organization called "Computer Using Educators." It is a three-year-old not-for-profit professional organization, California-based, that acts as a support group for computer using teachers.

It is a very exciting group of people, now with a national reputation, 2600 dues-paying members in 41 states and nine foreign countries.

CUE holds large conferences in California, one coming up again in May. Again, CUE is a not-for-profit organization sponsored by low registration fees paid by participants. At no time has any federal, state or other grant money been made available for CUE activities.

With CUE's help, our microcomputer center was formed, just about two years ago. It is a joint operation between CUE and the county office. It is part of the library facility which makes it unique. It is part of our instructional materials display center.

We consider that computer hardware and particularly computer software should be treated as a new form of instructional media to be integrated into existing media collections. And we demonstrate that in our office.

We currently have eleven microcomputers systems in the center, and educators from all over the country come in to have a "hands-on" experience in a noncommercial, relaxed environment.

All the hardware has been placed in the center on a long-term loan from the manufacturers. However, I don't suggest that anybody here should try that, because I don't think that you are going to get away with it.

We have an on-going series of demonstrations of new computer hardware and of new software on a regular basis. We also have other scheduled events for local teachers.

One of hte major tasks of our staff is to train teachers and school administrators in this new technology. The training ranges from computer awareness sessions for absolute beginners, to software evaluation sessions, to hands-on computer programming workshops for beginners and advanced.

We have created active computer-users groups for each major computer type that are used in the schools, and for special educators.

These groups meet to change ideas and teaching suggestions and have been a great source of in-service training.

All of the area colleges and universities have used our center for their computer-related courses, including Stanford University. We have supported these college courses and expect to sponsor a number of courses through other Bay Area colleges.

Our instructional Computing Coordinator works closely with county school districts helping them plan their computer related curriculum, directing their evaluation of software and helping them select computer hardware.

We maintain at the center an expensive collection of books and journals, including all of the current computer publications and computer in education publications, in addition to curriculum guides that we have collected from throughout the country.

We have a software of public domain computer programs that have been donated by teachers throughout the country. We have something over 300 programs that are available to teachers who come into our center, free.

If you come into our center, you can copy the disks that we have and walk out of there with over 300 programs free.

We also sell these diskettes by mail order, and in six months we have sold over 1000 diskettes throughout the country. We place these programs free in other offices throughout the country and other county offices in California where teachers are able to come in and have them free there, too.

The most recent project in our center is called the California Media Consortium for Classroom Evaluation. What we have discovered is that there are 3000 software pachages available on the market for schools, but less than 5 percent of them have been critically reviewed.

A group of 56 librarians in the State of California have taken it upon themselves to encourage teachers to critically evaluate these programs, using them with children. Our hope is that we will be able to disseminate these evaluations throughout the country soon.

We will disseminate both these evaluations and our free programs through electronic means. We haven't decided exactly how to do that. That is a tough one.

In your packet you will find a variety of supplemental materials including an application form for Computer-Using Educators.

Thank you.

DR. SEABORG: Thank you, LeRoy.

All right, the next speaker will be Robert Bell.

STATEMENT OF ROBERT BELL

GENERAL ELECTRIC COMPANY, SAN JOSE

MR. BELL: Dr. Seaborg and Members of the Commission, I am Robert C. Bell, Manager of Employee Communication and Community Relations for General Electric Company's nuclear energy business in San Jose, California.

In addition, I am currently president of the Industry Education Council of Santa Clara County in the heart of Silicon Valley.

The focus of my remarks today will be from General Electric's perspective as a member of industry. I will describe first our philosophical view of science, math and technology education and, second, I will translate those thoughts into action.

First of all, our views in this area go back to the very founding of General Electric and the reasons we still exist today more than 100 years later.

Our past and continued success as a profitable enterprise has been and will be the result of the creative efforts of thousands upon thousands of well-trained and educated scientists and engineers.

Over the past 100 years, few people's lives in this world have not been touched directly or indirectly by G. E. developed technologies. From our first light bulb to explorations in outer space, G. E. engineers and scientists have remained on the leading edge of numerous technological disciplines.

Our emphasis on technology is an integral part of our corporate culture. For the future we see no lessening of our need for a vast reservoir of technology-trained creative men and women.

And based on that view, we are concerned about the quality of science and math instruction in America. Overall, education in this country is a national resource of which we should all be proud.

All sectors of our society must work to protect and preserve our investment in the quality of its institutions. We also believe there is a second factor with much broader implications for our society as a whole, that is greater than General Electric's concern as a commercial high-technology enterprise.

As we look ahead, we see the computer being one of the most pervasive influences in our lives, at and away from work. Using that term "computer," I want to imply the broadest possible context. That is, the total body of hardware and software required to produce computers and all the products and services we can now and might in the future derive from their use.

I believe the importance of high-quality science and math education is clear. General Electric also feels

General Electric also feels that our role in the educational process should be to serve as an information resource, not as educators.

We think that we can best serve the educational process by stimulating and motivating students, teachers and counsellors to learn more about careers in inductry.

Having discussed our philosophical point of view, I want to shift gears from that plane to a pragmatical level and descrive three specific programs General Electric currently sponsors:

Educators in Industry

World of Work

Program to Increase Minority Engineering Graduates, or PIMEG, as we call it.

The Educators in Industry program is the result of General Electric's historic interest in what is now known as career education.

For more than 30 years, General Electric has published and provided career guidance booklets, posters and other materials for students, teachers and counselors.

In today's complex social climate, career education takes on new significance. The prospect of continuing high youth unemployment can be traced to a number of problems of various institutions that will not be solved easily.

However, the Educators in Industry concept addresses part of the dilemma. It provides educators with opportunities to learn about industrial careers by gaining first-hand knowledge of the nature and range of employment in their regions.

Educators are thus better equipped to prepare students for the world of work. In turn, communities and employers benefit from a better qualified labor pool. These graduate credit programs are usually held once a year under the auspices of local colleges and universities, with faculty members acting as coordinators to plan the course content in cooperation with representatives from G. E. and other businesses.

Each program is tailored to the employment needs and resources of our participating G. E. plant communities. Sessions are held at our industrial sites, with participation by employees of various backgrounds.

The program can include workshops, panel discussions, lectures and real time work experience. The General Electric Foundation, which is a separate independent trust, underwrites the major expenses for these programs in support of career education.

A second program sponsored by G. E. is called the World of Work. Principally a secondary school communication program, it is an integral part of our overall corporate objective of being an effective resource for education.

We seek to build mutually-rewarding relationships by, one, stimulating interest in the world of work and motivating students to be better than the best in school subjects and prepare themselves for their careers.

And, two, demonstrating support for educators by providing them with helpful career education materials.

The third General Electric effort I want to describe is PIMEG. That is our Program to Increase Minority Engineering Graduates.

Now ten years old, PIMEG was the first in a national effort to increase substantially the proportion of minorities in the pool of engineering talent in the United States.

Our most recent company-wide survey in 1980 reveals these efforts have improved and matured. They have evolved into many collaborative efforts with over 430 other employers and some 50 minority organizations.

This was accomplished through 80 continuing activities in 48 cities and communities in 22 states. We also have involved 1200 educators and more than 1100 parents in this process.

The participating G. E. businesses are contributing over one-half million dollars in scholarships and other activities that involve 28,500 minority students in PIMEG.

These resources are in addition to those committed at our corporate level, and those of the independent General Electric Foundation.

I have provided samples of these materials for the Commission staff. I would be happy to answer any questions you may have.

Thank you.

DR. SEABORG: Thank you. I hope that all of the speakers will stay until the end of this series of presentations. Then if there is time, we will have questions.

The next speaker is Olivia Martinez.

STATEMENT OF OLIVIA MARTINEZ

SAN JOSE UNIFIED SCHOOL DISTRICT

AND

CALIFORNIA ASSOCIATION FOR BILINGUAL EDUCATION

MS. MARTINEZ: Good afternoon. I want to begin by saying that I want to speak on a topic that is extremely timely for those of us in education.

My name is Olivia Martinez. I am the administrator of instruction and student services for the San Jose Unified School District. I am here speaking on behalf of our 33,000 students as well as the Limited English Speaking Student population in California.

Also, I am here on behalf of the California Association for Bilingual Education, of which I am the President.

In California, we have a very diverse population, as you well know. And my concern in preparing my remarks this morning was to try and give you some considerations regarding the numbers of limited English proficient students not only in California, but throughout the country.

Mathematics, science and technology have been, right here in the middle of Silicon Valley, a matter of deep interest to us. Mathematics particularly has been a subject that has been of considerable significance for limited English proficient students.

This is true mainly because students who do not fully comprehend or speak the English language often have been able to survive in the public schools because of their knowledge of the international language of mathematics.

Often it has been that grasp, that ability to perform in math that has really saved them from being relegated to special education programs or from labels of mentally retarded or otherwise put in a category of disparagement regarding their true potential.

So we consider mathematics to be a really key area for our students to be able to demonstrate their true potential and capability. Even given the fact that much of our mathematics instruction obviously is dependent upon language skill.

Now, our public schools in California and throughout the nation are in a period of very troubled times, as you well know. The situation of declining enrollment, coupled with the economy, the fiscal cutbacks and all of the critical budgetary issues that are facing public schools are causing us to rise to a challenge that we have not really had to meet before.

At the present time, our own district is going through considerable layoffs in personnel. As teacher seniority laws are written in our state, and I am sure throughout the country, the main consideration is, of course, to seniority.

This means that, for example, in our area many of the teachers that we will be losing from our system are in fact math and science teachers, younger math and science teachers, who have been hired in the more recent years. They are the very teachers who have come out benefitting from the most recent advances in mathematics and science education.

That is a real loss. That means the teachers that will remain in our schools teaching math and science may not have taught those subjects for many years or may never have, in fact, majored in either of those two topics.

This of course happens at a time when the universities are raising their requirements in math and science. I am sure most of you are aware of that. New demands have been made on the public school systems to excel their math and science instruction just when we may be losing our very best math and science teachers.

Now, some people may say that the quality of our math and science instruction in public schools has been lacking to begin with. Some will go even farther than that and say that we have not done a good job in teaching our teachers to teach math, that we have not paid enough attention to it, and that we have not done a good job in teaching, especially the qualitative aspects of mathematics.

Quantitatively speaking, we have been able to teach the children to compute and to master the basic requirements. But when it comes to their conceptual skills and analytical skills, the ability to really use mathematics in terms of being able to apply them to situations that demand a systematic analytical solution or problem solving, than we have been unable to teach them basic thinking skills -- teaching children to think and reason.

Now, we know that those skills are extremely important, not only for academic success in our public schools, but for success in life.

And into all of this dilemma, I ask you to consider wherein lies the limited English proficient student, the student who comes from a home where English is not the first language, or comes from an environment where another language is spoken.

We know from the basic research that has been done in the last 10 years, and from our practical experience really over the last few years, that a student learns best when he is taught in a language he understands.

We also know that once a student has mastered basic concepts and basic skills, he can very easily transfer those skills over to the newly acquired-second language, English.

And we know that a student can learn English very capably and in fact master the English language without having to sacrifice learning the basic subject matter at the same time.

So given this experience, and seeing how children can succeed when they are placed in an environment where their language needs are taken into consideration, we have to consider that of the ---

Is that my time is up?

DR. SEABORG: Two minutes, one or two minutes.

MS. MARTINEZ: Of the approximately 3.8 million children in the United States today who are limited English proficient, fewer than 25 percent -- in fact, barely 17 percent -- are currently in programs where their language needs are taken into consideration.

Given these two situations, with the struggle we have in our public schools and the numbers of language minority students who need and can excell in math-science areas, we were really at a loss as to what to do.

We were elated several years ago when we had the opportunity to come into contact with several researchers, Dr. Edward De Avila, Dr. Elizabeth Cohen and Dr. Joann Intili, who were able to come into our school system, in our environment, consider our needs and bring to us a language-based math-science curriculum that has been outstanding.

It has been a remarkable success, and we thought it was one of the most promising things we have seen in a long time. That is basically what I wanted to being to your attention today.

Because we have gotten teachers who by their own admission tell us, "science and math is not my forte. I don't feel comfortable teaching it." They have now become some of the most exciting math-science teachers that we have.

And a lot of that has to do with the fact that a good teacher will teach and master the basics. But we desperately need new ways to approach problems that are not readily solved in traditional ways.

We feel that this project, the Multicultural Improvement of Cognitive Abilities Project, is one that really could be considered as it particularly addresses the language needs of children whose language is not English.

We are also thinking of applying it to our gifted population because of the ability it has to take mathematics and science and turn it into an exciting learning experience, even into complex analytical problems that would not even be introduced until at least the high school level.

So we are really pleased about that. And now my time is up. So I have brought for you to take to read at your convenience a copy of the executive summary of the final report that explains more in detail the report I referred to. So I will leave that for your information.

Thank you.

DR. SEABORG: Thank you.

Do we have a representative from the Governor's office here today?

MS. HUBNER: Yes.

DR. SEABORG: I thought so. Would you introduce yourself?

STATEMENT OF JUDITH HUBNER

REPRESENTATIVE OF THE GOVERNOR'S OFFICE

STATE OF CALIFORNIA

DR. HUBNER: My name is Judith Hubner. I am a special assistant in the Governor's office. Governor Brown regrets very much that he could not be here. He has to be in Sacramento today to work with the Legislature on pressing budget issues.

It is a privilege for me to present to you the Governor's proposal for improving math, science and technological education in California.

First, we eant to congratulate the National Commission on Excellence in Education for holding this public hearing on Science, Mathematics and Technology Education. There are few more important issues for our nation.

In his January 1982 State of the State address, Governor Brown said, "Our propriety, even our survival depends on our will to invest in people."

He called for policies to insure that every California high school student studies at least three years of mathematics and two years of science, with even more courses for those going on to higher education.

The Governor's concern for math, science and computer education is rooted in the fundamental shift occurring as become an information society.

Nationwide, most workers today are engaged in the creation and processing of information. Computer programming and other technological skills are demanded, not only in new industries but in such traditional occupations as banking, teaching, insurance and clerical work.

Between 1955 and today, information-related jobs increased from 17 percent to 55 percent of the total work force. In California, nearly 40 percent of all new jobs in this decade will depend directly or indirectly on high technology-related business.

The new technologies such as microprocessing, robotics, satellite communications and biotechnology are already in process of transforming the way we work and live.

And yet at the same time we are failing to produce the scientists, mathematicians, engineers, teachers and technologically literate citizens required by these changes.

As California switches to an information-based economy, our society is being transformed as profoundly as during our 19th Century shift from agriculture to industry. This means that education's mission also must change:

- The public must make an adequate investment in public schools to accomplish the necessary changes.

- Teachers must be brought up to date both in new subject matter content and in effective teaching methods.
- The public and private sectors will have to cooperate to ensure that our youth finish school equipped and ready for productive participation in the work force.
- We must find new incentives to continue attracting fine teachers and professors to provide our children and young people with the education they deserve.
- Families, schools and private industry must join together in a concerted effort to provide all students with the technological sophistication necessary to work and live in the information society of the 1980's.

I would particularly like to call your attention to the importance of promoting interactive computer learning. Computers not only offer the potential for improving student achievment in existing subject-matter areas through computer-assisted instruction and computer-managed instruction; but more importantly, computers can expand the intellectual and problem-solving capabilities of children through interactive learning activities never before possible.

They offer the potential to go beyond our present understandings of many specific subject domains, even into new understandings of the very process of learning itself.

And, finally, computers offer mass access to information banks which have heretofore been the preserve of technical specialists.

We stand today at the threshhold of an intellectual revolution. We have yet to begin to assimilate the sweeping potential of electronic technology to transform the way we think and live and work.

The Governor has set out a series of proposals in this year's budget to begin a new process for fostering excellence in public school math/science, computer and related instruction; in community college high technology job training; and in university engineering and computer science education.

Let me today outline his proposals for our elementary, junior and senior high schools.

The thrust of the K-12 initiative is to meet the states' shortage of qualified math, science and computer-literate teachers. The Governor's K-12 initiative has three basic components.

The key component proposes a California-wide network of regional teacher education centers (TECs). TECs, controlled by the local education community, would establish summer institutes and school-year training programs, house computer demonstration and training facilities, and coordinate training efforts between the public and private sector and between higher education institutions and local schools.

TEC centers would also provide software evaluation services and programming capabilities for enhancing teachers' computer literacy.

The second component of the K-12 initiative proposes funding for local schools to send their teachers to TEC-approved training programs. Local school site councils -- with teachers, administrators, parents and students represented -- would prepare staff development plans to meet their local needs for improving their math, science and/or computer education.

The plan could include stipends and release time, as well as the purchase of instructional materials for use by teachers in the classroom, including math and science text books, science equipment and computer software.

Priority would go to teachers in grades 7 to 12, where there is an immediate need for improvements, in order to meet both the new university entrance requirements and current employer demands for an entry-level workforce trained in math, science and technology.

The third component of the K-12 initiative proposes funding for a diversity of local and state-wide programs to provide quality inservice training for our teachers in math, science and computer education.

An advisory council composed of representatives from California's education, business and labor communities would allocate grants for summer institutes and exemplary projects. Priority would be given to programs with demonstrated effectiveness.

For your interest, I am providing you with a copy of this testimony and a fuller description of each of the Governor's proposed programs.

Thank you for this opportunity to present the Governor's proposal. I will be happy to answer any questions.

DR. SEABORG: Thank you. Can you spend another hour with us?

DR. HUBNER: I would be delighted.

DR. SEABORG: The next speaker is Robert W. Walker.

STATEMENT OF ROBERT W. WALKER

FOOTHILL-DE ANZA COMMUNITY COLLEGE DISTRICT

MR. WALKER: I represent the Foothill-De Anza Community College District as Director of Vocational Education.

I guess I will take just a slight change of pace, in the sense that we have concentrated pretty much on the secondary issue.

The Foothill-De Anza Community College District is one of surprising size. We have a population base of 300,000 people in six communities in our area, and 41,000 students -- 8,000 of those are full-time students.

We have the equivalent of 23,800 full-time students attending the two campuses, three off-campus sites and the 70 random industrial community sites.

From the inception, our district has maintained a very active and responsible, I believe, vocational and technical program built upon the concept that basic and university education should not be separated from technical education.

Each of the seventy-nine vocational programs in our district are housed within an academic division and administered, managed and coordinated as any other academic program on the campus.

We have therefore avoided, I believe, the technical college influence. We are an academic institution even at the vocational-technical level.

As a result, I believe our programs simply are exemplary. They are exemplary because of the very close working relationship between those math and science teachers who are teaching transfer students for the university who are able to work very closely with the technical faculty whose primary concern is moving students into the work force at some level.

When I was asked to identify exemplary programs in our district, I found myself facing quite a dilemma. I really don't know what an exemplary program is. I guess I would define an exemplary program at the community college in vocational-technical education as being one which is:

(a) Satisfying to the students who are trying to enter the program and are graduating.

(b) Is serving the marketplace by providing qualified graduates.

(c) Is providing a group of students and graduates who are demonstrating every day high levels of competency.

I think if we use those definitions to identify exemplary programs at Foothill College or De Anza College, we probably would be talking about some 30 or 35 of the 70-some programs in the district.

Each of our programs, I believe, is measured on the basis of how well they satisfy that exemplary definition. Each of them is retained, expanded on the basis of that type of definition.

As a result, in the last two or three years, as the financial crisis has struck the district -- as they have almost any other district in the State of California -- it is programs which did not meet that definition of exemplary status that have been reduced in size, eliminated, or are in the process of being very carefully examined to see whether or not the district has the resources to support a program which cannot meet the definition of exemplary status.

In my mind, the reason that many of our programs, at Foothill-De Anza and any other community colleges in the State of California, have maintained the quality of technical education for which they have been given credit has been four-fold.

I think a magnificent accumulation of highly-qualified faculty have been available to us, certainly since I entered the system in 1963.

We have had unusual levels of financial support. We have had an unbelievable level of qualified entering students into the vocational programs.

To give you just a single example, I spent 14 years directing a dental hygiene program at Foothill College. In that 14 years, we never were put in a position of accepting a student -- being forced to accept a student -- who did not qualify at the highest level for entry into the university status.

As a matter of fact, from that program, from the dental hygiene program, in the most recent 300 graduates, 116 have received since graduation from Foothill their baccalaureate degrees, their masters degrees or a doctorate.

That kind of student entering a vocational program at the community college level cannot help but provide excellent graduates from a program.

And, finally, we have had continued excellent support from the community, commercial and professional areas. Now that is the good news.

The bad news is what may lie across the horizon for us. We are finding it very, very difficult to maintain programs in which we are required to provide very small numbers -- or provide very large numbers of faculty for very small numbers of students.

The health sciences, for instance, is a good example -- a very good example. Most of the vocational programs, particularly those represented by high technology, fall into that category.

Secondly, we are finding it more and more difficult to attract qualified high technology faculty. Try to compete with General Electric and Bob Bell, or Hewlett-Packard for an engineer instructor in electronics or in data processing.

We are also faced with an increasing sophistication and cost of equipment. This year we had requests from our technical-vocational programs for $600,000 worth of equipment, $400,000 of which we identified as being critically necessary for replacement or addition to the programs.

We were able to fund only $55,000 of that $400,000 critical need.

We have a significant problem with the diversity of the types of training whihc we are being asked to provide. Electronic firms need very specially trained people. We cannot provide that kind of specificity for every graduate from our program.

We must agree with the community, the commercial community, on what basic training levels are. I think we will be able to maintain the quality of our educational program in the Foothill-De Anza District.

We most likely will not be able to continue to provide the large number of programs and the breadth of programs, unless very significant changes occur in funding and organization of the community college programs.

Thank you for the opportunity to speak.

DR. SEABORG: Thank you.

The next five speakers are colleagues of mine.
The next is Nancy Kreinberg.

STATEMENT OF NANCY KREINBERG

DIRECTOR, MATH AND SCIENCE EDUCATION FOR WOMEN

LAWRENCE HALL OF SCIENCE, BERKELEY

MS. KREINBERG: I am director of the Math and Science Education Program for Women in Lawrence Hall of Science, which is a public science center teacher training institute, and research and development center in science education at The University of California, Berkeley.

My work for the last ten years has been to increase the participation of girls and women in math and sciences courses, so they will be better prepared to enter scientific and technical fields of study.

The program I direct encompasses direct services to students, teacher training, curriculum development, and parent and community education.

I have described each of these components in my written testimony, and I have brought samples of our material with me.

I would like to use my time to summarize what my colleagues and I have found to be the essential elements for successful teacher-training programs and to suggest what are the major components of change needed to significantly increase the participation of women and minorities in math and science education over the next decade.

Our teacher-training program, which is called

EQUALS, has provided 1500 California teachers with 30 hours of inservice in math education and computer education, and we have provided another 2000 teachers outside of California with approximately 10 hours of inservice each.

The impact of this program, in schools in which we have been working for two or more years, has been to increase the enrollment of women in advanced mathematics classes.

We are also seeing that all students of our EQUALS teachers are showing improved attitudes towards the study of mathematics and an increased interest in math and science related careers.

We have found four components to be essential to an effective teacher training program.

First, the participants must have an investment in the problem. In EQUALS, we have the teachers conduct research studies before they come to our program:

studies on student enrollments
career aspirations
students' attitudes toward computers

The teachers come to EQUALS as experts on certain topics in their schools. Then together we talk about how we might solve some of these problems that they have found.

Second, the materials that we provide the teachers must be immediately usable in the classroom. That means the next day, not next week, not next summer. The EQUALS staff are all experienced teachers, and the materials that we give the teachers have been thoroughly field tested both with teachers and students.

Third, we establish a nonthreatening, cooperative learning environment. We minimize the fear of failure and we encourage risk-taking. Once teachers see the power of this kind of learning environment, they are motivated to try and cultivate it in their own classrooms.

And, finally, we encourage professional development. At a time when many teachers are leaving education, programs such as ours provide a place where teachers can air their problems, grievances, and frustrations, while at the same time they work toward a constructive goal for their students.

They begin to see themselves as advocates and leaders in achieving the goals of the program. For example, one of our high school teachers wrote:

> "I find that I do not have to be in total control of the class at all times. I was always afraid to move off the straight line of my objective. I have learned that my teaching objective can be reached by other means. You have changed my opinion about workshops and what can be done in classrooms. You helped me learn

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courses are needed. The traditional junior high shop course that you and I took is still being taken. This course could be replaced by an Introduction to Technology, helping students learn how things work and exploring various technological systems through hands-on activities such as building a circuit board or solar panel. Girls in particular would benefit from such courses.

Third, we need increased course requirements. It will be necessary to increase the math and science requirements for high school graduation if our students are to schieve some math and science literacy. But without the necessary teacher preparation and curriculum improvements, increased enrollments by themselves will not improve literacy.

We need industry education linkages. A collaborative program could increase industries awareness of the need and potential for women and minorities to enter scientific fields. Research in industry projects for counselors could facilitate getting relevant career information into the schools. Mobile vans might travel to elementary and secondary schools affering hands-on prevocational courses with tools and equipment not normally available in the schools. Both boys and girls could then have a chance to learn mechanical skills and understand how they are used.

new things about students and gain a better understanding of myself. You have given me the opportunity to try things I never would have done on my own."

That is one of the things we mean by professional development.

Now, to what is needed over the long run to improve math and science education for all of our students. First on my list, and I suspect most people's lists in this room, is teacher training.

We are losing our math and science teachers to retirement and industry. Our inservice resources are being cut back. Rather than cut back, what we need at this time is a recommitment to teacher training.

We need new courses focusing on mathematical literacy to help teachers to acquire an overview and a familiarity with mathematical topics.

We need indepth work on the teaching of problem solving and the use of manipulative materials to teach abstract concepts,and we need instruction in small group teaching and learning strategies.

These courses need to be offered to both inservice and preservice teachers.

Second, we need curriculum improvement. New

Finally, my favorite innovation would be parent education. Not in the old sense of parent awareness, but parents and children learning mathematics together. We have developed a pilot program called "Family Math" that seems very promising in this area.

But to do all this, it will take a national commitment and federal leadership to make quality math and science education a national priority.

Thank you.

DR. SEABORG: Thank you.

The next speaker is Robert Finnell.

STATEMENT OF ROBERT FINNELL

MESA PROJECT, LAWRENCE HALL OF SCIENCE, BERKELEY

MR. FINNELL: My name is Bob Finnell. I am executive director of Mathematics, Engineering and Science Achievement Program at the Lawrence Hall of Science in Berkeley.

MESA's objective is to increase the number of high school graduates within three or four years of math, science and English, so that they have the option to pursue a math-based field of study at a university.

MESA operates in 100 high schools in 29 school districts. About half of our 2700 students are young women. We have an equal number of black and hispanic students and about 2% American Indian, Puerto Rican and other students.

Why are we working on this task? After looking at the 200 racially-isolated schools in California we found that very few students were pursuing math-based fields of study. We felt MESA could enable students from those schools to become a part of the economic and professional life vital to our nation.

I want to tell you two things about MESA:

How we work and what we produce.

In the sweet bye and bye, we will perhaps solve the problems of teacher shortages, lack of funds, and other major challenges and structural problems faced by schools.

But in the meantime, we will produce fewer prepared students if we do not use program models that are available today to produce the educational results that many of us here today feel our society needs. How does the MESA model work?

First, MESA has been able to accomplish what it did because it had a clear objective. We wanted to graduate students with three or four years of math, science and English.

Second, MESA built our program around incentives. We only keep the students in the program when they pursue math and science courses. They are allowed to participate in academic year activities on our summer program (or our field trips or study workshops) in recognition they are doing extra academic work.

Third, MESA built a cooperative network of faculty, industry, school district, professional society and other volunteers. At each center MESA is associated with five to 10 high schools where faculty members, corporate volunteers, professional society volunteers, and parents work with the students or serve on the local advisory boards.

In addition, the MESA program is built around a sense of community so the MESA students receive reinforcement from peers, from parents, and/or from outside volunteers. They communicate that math and science achievement in the technical areas is important. This support counteracts what you and I know goes on in schools where academics does not always occupy a high value.

There are several other factors that I think are crucial to MESA. It is essential to have a professional staff dedicated to work with the teachers and volunteers.

It is crucial to have multiple sources of funding. MESA spends about $400 a year on its students. We don't think you can prepare students adequately within predominantly Black and Hispanic schools without supplementing the existing programs with additional activities and services that cost money.

MESA's resources come mostly from the private sector: Hewlett Sloan Foundations at the major corporations in California. But we have seen support from the public university systems.

And, finally, MESA measures the results of the program to see if we are altering the behavior patterns of students at schools. The average Hispanic or Black student in California did not complete the first year of math and science.

MESA measures whether the students have taken the courses. We also measure whether they are graduating, then we measure whether they are pursuing math-based fields of study at a university.

Let me spend a couple of minutes reporting on the MESA graduates and what teachers say about our program. Follow-up studies were conducted for the June '79, '80 and '81 graduates. We had about 250, 500 and 700 graduates, respectively, in each of those three years. And the pattern has been about the same.

Ninety-four percent of them have gone on to attend a post-secondary institution. You are aware that 90 percent of the minority students in California go to community colleges.

From 10 to 15 percent of the students in MESA attend a community college. On the average each year, 28 percent attend the University of California system, about 29 percent the state university system, and about 20 percent private or independent institutions within the state, and about 10 percent go out of the state.

In terms of their career choice, about 69 percent of the MESA graduates have chosen math-based fields of study: over half of the latter chose engineering. Currently, for example, about 30 Blacks a year (out of 4000 graduates in engineering) receive B. S. engineering degrees from California . MESA has had over 200 a year who have chosen engineering. If you take the worst case scenario, which would be 15 percent, or your best case scenarios, you see that we should have major impact on graduation rates in the years ahead.

MESA has been in business since 1970. We did a study of the students who were in the program in the early 1970's. We found that had every other racially-isolated high school produced as many B. S. graduates, at the first MESA high school, we would not have been able to make a case for expanding the MESA program because a high number of B. S. graduates would have been minority.

We are now studying the second group of graduates from the mid-70s. So far 90 percent of them have received B. S. Degrees.

In the MESA program we have been able to track our students and see if they are graduating in math based areas.

MESA is in racially-isolated high schools in large school districts in suburban areas as well as rural areas. The MESA model though is not restricted to working with minority students. We felt it vital to recognize that design could be applied on a wider scale.

99 percent of the dollars directed at minority students went to nontechnical areas, although most of our jobs are in high technology areas. 20 to 25 percent of our university degrees are in these areas. We want resources allotted for minorities to reflect the countries need for math based graduates.

MESA, then, is an approach to using existing resources to produce the kinds of graduates that our nation needs to strengthen its economy.

Thank you.

DR. SEABORG: Thank you.

The next speaker is Marian Koshland.

STATEMENT OF MARIAN E. KOSHLAND

PROFESSOR OF MICROBIOLOGY AND IMMUNOLOGY, BERKELEY

MEMBER, NATIONAL SCIENCE BOARD

MS. KOSHLAND: I am Marian E. Koshland, Professor of Microbiology and Immunology at the University of California at Berkeley. I am also a member of the National Science Board, chairman of their budget committee. And it is in that capacity that I am here today.

I appreciate the opportunity to meet with the Commission on Excellence in Education, and discuss the concerns of the National Science Board regarding the quality of science and mathematics and engineering education in the United States.

And as I am sure most of you are aware, recent budget stringencies have considerably reduced the educational activities of the National Science Foundation.

This reduced support has come at a time when there is evidence that the United States' position in science, technology and industry is deteriorating.

The reduced support has also come at a time when there are symptoms of serious deterioration in our education of scientists, engineers and technologists.

In view of these circumstances, the National Science Board met last summer and tried to consider how a foundation with limited resources could carry out its responsibilities under the National Science Act, and I quote, "To recommend and encourage national policies for the promotion of education in the sciences and to initiate support programs to strengthen science education at all levels."

Well, the board agreed on two approaches. The first priority lies in supporting research-level education because that is the unique responsibility of a board. And this priority is being implemented in the form of free doctoral fellowships and by the support of undergraduate students, graduate students and post-doctorate fellows by research grants.

The second priority, however, that the board agreed on was to play a catalytic role in areas of science education where the foundation did not have the major responsibility. And this role could be carried out by identifying needs and concerns in these areas and by intervening in high-leverage areas where you could expect significant outcomes with an investment of very limited amounts of money.

Now, as the first step in implementing this catalytic role, the director of the foundation and the board have established a commission on pre-college education in mathematics, science and technology.

And Lew Branscomb, chairman of the board, met with your Commission on February 25th in Washington to describe the plan to the Commission and our desire to work with you.

And it is in that spirit that I am here today.

Now, as the title implies, the work of the Commission will focus on secondary education. In discussing the possible catalytic roles of the foundation with a number of people in the scientific and education communities, we heard again and again about the critical role of secondary education.

The qualities and basic skills provided by secondary education are essential to later success in the demanding fields of science and engineering. Even eligibility for further training is at stake. And seemingly innocuous student decisions to avoid difficult courses can effectively preclude their participation in important educational and occupational areas.

So the secondary education is really an important time of specialization and focus. For approximately half the student population, this is their only opportunity for formal education in mathematics and science.

And for the half that enters higher education, this is of course the stage for differentiation into and preparation for future study.

We also, of course, heard again and again from advisors about the problems confronting science education at the secondary level. And I am sure you have heard these catalogued many times.

They include the declining level of requirements for achievment in science and mathematics in order to graduate and thus the declining enrollment in mathematics and science courses.

They include outmoded curricula, archaic and non-functioning equipment, critical shortages of teachers in biology, science, physics, chemistry, et cetera, and a high incidence of unprepared and unqualified persons who are teaching these courses.

Now of course, the problem -- can I have a few minutes more?

DR. SEABORG: You have two minutes more.

DR. KOSHLAND: All right, two minutes more.

Now, of course, the problem of education improvement is basically that and has to be solved by the local school boards. It is their responsibility and we would want it that way, in order to maintain the kind of diversity and independence and flexibility to which we are all committed.

But because there are so many issues of national importance attached to secondary school education, the board felt it had to do something, find some way to engage the nation's scientific community in local activities and establish a stronger base of secondary school education.

And the Commission's charge is not simply to do with study, not to assess the quality of secondary education, but it is really to come up with an action plan to prescribe ways to address the needs of secondary science education and identify the specific responsibility of the National Science Foundation and other federal agencies, state and local governments, private foundations, et cetera.

And the board is excited by the prospects of the Commission's work and eagerly awaits its findings.

I think I will submit the rest to testimony and say only in conclusion that, as the Commission on Excellence in Education continues its work, we hope you will examine particularly carefully the needs and problems in secondary education in science and mathematics.

And that the efforts of the National Science Board Commission will have the effect of extending and complimenting your activities.

Thank you.

DR. SEABORG: Thank you.

As Marian has indicated, our Commission has close cooperation with the National Science Board through its Chairman, Lewis Branscomb, in their efforts toward the solution of this problem of education in science and mathematics and technology which is so critical to the future of our country.

Thank you.

The next speaker is Alan M. Portis.

STATEMENT OF ALAN M. PORTIS

PROFESSOR OF PHYSICS, UNIVERSITY OF CALIFORNIA, BERKELEY

CHAIRMAN, EDUCATION COMMITTEE, AMERICAN PHYSICAL SOCIETY

MR. PORTIS: Mr. Chairman, Members of the Commission and staff, I am Alan Portis. I teach physics at the University of California, Berkeley. And I am presently chairman of the Education Committee of the American Physical Society. And it is in this latter category that I am here today.

Thank you very much for inviting me to appear at this hearing concerned with science, mathematics and technology education. This is a subject of particular concern to the American Physical Society, the professional membership organization of American physicists.

The American Physical Society and its Education Committee are engaged in a number of programs to improve physics education at the secondary, college and graduate levels.

For example, the Education Committee, in cooperation with the American Association of Physics Teachers is engaged in a college/high school teacher interaction project that encourages college physics departments as well as physics research laboratories to assist local high school physics teachers.

Through this program, nearly three thousand high school physics teachers have been surveyed regarding their needs.

The two organizations are now working with local physicists to address those needs. Other American Physical Society programs are designed to involve industrial organizations in the improvement of physics education.

I believe that we are now in a period of substantial change in which industrial organizations as well as regional and state government, not to mention colleges and universities, must take major initiatives to improve the educational process.

The Honorable James Hunt, the Governor of the State of North Carolina, early this year addressed the annual meeting of the American Association for the Advancement of Science on the topic "Academia, Industry and Government: The Organization Frontier of Science Today."

Governor Hunt described an emerging crisis in economic productivity, education and environmental management. His feeling is that the private sector, through free market forces alone, will not be able to avert this crisis, nor will a return to what has traditionally been the federal role be adequate.

Instead, a redefinition of the role of government is needed. The governor calls for state, regional and local government to take the responsibility for encouraging technological development with the federal government playing an important supportive role.

As Governor Hunt points out, such an effort must engage industry and academia as well as government. I would add to this triad professional organizations such as the American Physical Society, the American Association of Physics Teachers and the American Association for the Advancement of Science, certainly, as well as many others.

We are hopeful in the American Physical Society that the National Science Board's Commission on Pre-College Education in Mathematics, Science and Technology will effectively be able to address the very serious concerns that we have with the quality of secondary school education in mathematics and science.

As Professor Koshland mentioned and as Dr. Seaborg also mentioned, the charter of this group explicitly directs the NSB Commission to interact with the National Commission on Excellence in Education in a manner designed to achieve maximum coordination and to minimize duplication of effort.

Speaking for my physics colleagues, we have every confidence that this Commission will for its own part work closely with the NSB Commission.

Finally, I would like to take this opportunity to make some personal comments on the problem of promoting excellence in education while maintaining access to education.

I was heartened, as I know you were, Glenn, by

Ruth Willis' mention -- the unsolicited mention, really -- of the Lawrence Hall of Science and its program and what that has meant to her and the programs with which she is involved.

Many have felt that in the recent past because of limited resources the quality of education has suffered as increased access has been achieved.

We are now seeing, for example in the increased admissions requirements of public universities in California and elsewhere, a renewed concern with the preparation of undergraduates.

To improve the level of preparation of undergraduates while reducing access to higher education is no great trick.

To do this and at the same time to maintain access will require major new initiatives of the sort that Governor Hunt has suggested and that the National Science Board's Commission, as well as this Commission, contemplates.

Although, in part, these initiatives may be expected at local, state and regional levels, we must look to the national level -- and I underline this -- we must look to the national level for leadership.

To maintain access while achieving excellence is to my mind the major challenge to this Commission.

Thank you.

DR. SEABORG: Thank you.

The Members here of this Commission are going to visit the Lawrence Hall of Science tomorrow morning.

And I was interested to hear your reference to the address by Governor Hunt. I also heard an impressive talk by him at the annual meeting of the American Association for the Advancement of Science in Washington earlier in January.

I think the program in North Carolina is worthy of careful study by this Commission. It is very impressive.

MR. PORTIS: Yes, that is the address to which I referred. I did bring a number of copies of his address along for thise Commissioners who are here.

DR. SEABORG: Good. I think they would like to have that, yes. Thank you.

The next speaker is Leon Henkin.

STATEMENT OF LEON HENKIN

PROFESSOR OF MATHEMATICS, UNIVERSITY OF CALIFORNIA, BERKELEY

CHAIRMAN, U. S. COMMISSION ON MATHEMATICAL INSTRUCTION

MR. HENKIN: I am Leon Henkin, Professor of Mathematics at the University of California at Berkeley. And I have been sent here to tell you something by an outfit called the United States Commission on Mathematical Instruction, which I chair.

Members of this National Commission on Excellence in Education, I have been sitting here with you all day, and I think you will be relieved to know that I have no new ideas to place before you.

(Laughter.)

MR. HENKIN: All of the ideas that I came to tell you about in my five to seven minutes have been expressed by others earlier today, and indeed many other fine ideas have been expressed.

It goes without saying that there is no chance in the world that we can put into effect all these fine ideas, really. Besides generating ideas, we have to have some ways of narrowing down, choosing, focusing on resources.

And this is where our Commission on Mathematical Instruction has something to say.

In 1981, the Commission adopted the following statement:

"Despite the very serious and urgent problems of improving scientific and mathematical education to meet personal needs of this decade, the United States Commission for Mathematical Instruction believes that the greatest need and opportunity for improvement in mathematical instruction over the long term lies at the elementary school level.

"There is a widespread but fallacious view that elementary school mathematics must consist solely in the learning of mathematical rules of computation.

"Elementary school teachers must be provided with the knowledge and instructional skills that enable them to bring a fuller notion of mathematics to their classes. Work on the problem at this level cannot be postponed."

I was interested to hear Dr. Koshland stressing the secondary level. And I think it is important. But our Commission really thinks the elementary teacher plays a more crucial role.

Here are a few of the reasons I put together to explain this.

First of all, many students are "de-motivated" from continuing their mathematical studies by the impressions received from their contact with mathematics at the earliest garde levels.

Secondly, mathematical learning, more than in any other subject, is cumulative, so that weakness in the early learning undermines comprehension and skills in the later parts of mathematics.

I know that we are concerned here with science and technology, as well as mathematics. But college instructors in science and in engineering generally feel that mathematical preparation is more important for the success of students in their courses, then pre-college work in the sciences themselves.

Also, as has been mentioned today, to function as citizens in a democratic society where technological developments are accelerating, it is essential to raise the mathematical comprehension of students who study even the least amount of required mathematics.

And I may add to that, at the elementary level, we really don't know yet which students are going to go on to the farthest studies of mathematics. Too often, on the basis of ethnicity, social class and the like, students are expected not to go on. But obviously we must try to develop our schools in such a way that at the elementary school level we don't -- we give the kind of opportunities for each student to go as far as possible in their later studies.

One of the last reasons I put down for emphasizing the elementary school level is, that enlarging the perspective of mathematics possessed by elementary students, provides a way of broadening their parents' views on what mathematics is and how it functions, improving in turn the level of their influence back upon the schools. I have seen many fine efforts at the improvement of mathematics instructions tackled and brought to a halt because of doubts that this material was really considered to be mathematics, because it was so different from what traditionally had been thought of as constituting mathematics.

Well, paying heed to the beeping I hear coming through my right ear, I would go back to the idea that we need to tackle this problem both in the long term and the short term.

From the long-term point of view, we must quite change the nature of our mathematics teachers in elementary schools, getting highly trained people. And that of course involves restructuring the financial basis in order to attract these people in competition with the other possibilities that they have.

But in the short term, we must obviously pour in a tremendous amount of support for our current elementary school teachers, with continuing help. Not just the institutes of the kinds NSF used to have, but I dream of a situation where any evening that puzzling question comes up for an elementary teacher, he or she can make contact with high school teachers or a university teacher in order to get some needed help.

Also, the idea came to us earlier today of involving current scientists in industry, as well as in universities, in keeping in contact with the school teachers at all levels.

I think the main focus has to be on teachers. But as several other speakers have mentioned, a lot more has to be done on new curriculum developments, and on bringing the new technological developments in to students, as a large part of the old curricula will become obsolete.

Thanks.

DR. SEABORG: Thank you.

The next speaker is John Pawson.

STATEMENT OF JOHN PAWSON

EDISON HIGH SCHOOL, HUNTINGTON BEACH, CALIFORNIA

MR. PAWSON: My name is John Pawson. I have taught science at Edison High School, Huntington Beach, for the last 10 years. I am currently involved in a program for the gifted and talented kids. And I also teach anatomy and physiology programs at the high school.

Dr. Seaborg, and distinguished members of the Commission, I would like to take this opportunity to express my appreciation for allowing me this time to give oral testimony today.

For the past two summers, I have lobbied the White House, Members of Congress, the Department of Education for just such a Commission that is here today.

And I take great pleasure that this Commission has been established as one positive step towards solving the educational plight that faces the Unites States today.

As you have read in my written testimony, as a teacher in the public schools I have become increasingly concerned about the quality of education that is provided for today's students.

The myriad of educational problems that the schools face today lies with the attitudes of the American society. For too long, Americans have expected the schools to shoulder the burden not only of educating the student, but also of curing society's discontents.

Now, with severe financial cutbacks, the voting populace wants even more from the schools. The current attitude toward public schools is quite negative. I personally believe that if we are to correct the educational problems that schools face today, the public attitude toward education must change.

Yes, we as teachers and educators have done a poor job in informing the public as to the school's problems, needs, and on the positive side, their academic achievments. Public relations have not been a strong suit in our educational community.

The political winds of our times have put the schools in a financial quagmire, and these undue pressures might spell the end of public education and with it the end of our American society and its democratic freedom.

As a science teacher, I am very concerned about the future of this country with respect to our technological superiority.

The public has failed to make the vital connection between our fabulous lifestyle, our national security, our technology and the quality of education.

Many countries around the world are spending a great deal of money and effort in their science and technology programs, while the United States wallows in indecision as to what programs to cut.

My recommendations are:

1. Reduce the social pressures on the schools. The main purpose of schools is to provide the student with information and develop within him the ability to make reasonable and rational decisions based upon that information. Schools only reflect society's ills and they really cannot correct them.

2. Reduce class size. Increasing the contact between the student and the teacher on an individual level is far more educationally influential than in large group instruction.

A small teacher/student ratio would also increase the effectiveness of the teacher in getting to know the student and his needs and thereby improving the quality of education.

3. Increase money for the schools in noncategorical aid. Let's face the facts that teachers' salaries must be made equivalent with industry or we will lose good teachers.

School instructional supplies must be in adequate supply. Each school district with different parameters should also be allowed to distribute money according to their individual needs. Although money will not solve all of education's multitude of problems, it will help.

4. Create a new reprioritizing of national commitments to education. President Reagan must set the national tone and convey to the public the importance of education to our national survival. Twenty percent cuts in education and twelve percent cuts in science research grants is an indication of the severity of the situation.

Mathematics and science education are interwoven in the fabric of our national security and the public must come to understand this. To remain a viable world power, the United States is going to have to come to grips with its destiny and plan for the future.

The pervasive attitude across this country had been quite the opposite with education falling in the lower priority than other types of entertainment.

5. The curriculum must become more relevant for the 1990s and through the early 2000s. Increasing graduation requirements in mathematics and science is a must if we are to compete successfully in a future world of highly complex technology.

Our students of today are leaders of tomorrow and they must be better prepared to meet those future challenges.

6. Education planning must be done on a long-term basis. The United States today needs an educational plan based on the future needs of the country and not on the

current day-to-day crisis.

The Department of Education and each state's department of education should work together to devise a plan that will deal with long-range problems.

7. Increase the length of the school day and provide for summer school programs. Like increasing the graduation requirement, today's students must come to realize that they must maximize their educational experiences if they, as individuals, are going to be successful. Summer school programs offered enrichment to the standard educational programs and provided additional help to students who fell behind during the school year.

8. Straighten out the financing of the schools. Uncertainty and obvious political decisions have kept school boards across our country floating on a nightmarish sea.

To be effective, schools must have a stable financial knowledge so they can plan accordingly, and decrease the decimating effect that these financial crises have brought upon staff morale and educational programs which benefit students.

9. Finally, maintain a special presidential commission for education. This commission would be necessary to bridge the gap between governmental leaders and the realities of the educational world.

From my limited experience, I have found governmental leaders willing to listen and to work with you, if you only communicate with them.

This permanent commission made up of teachers, business, and governmental leaders is one small step increasing the communication between the educational community and government.

I realize that many of my proposals involve the responsibilities of the states and local school boards along with the federal government.

This Commission here today can provide the national direction and work with those groups. A further perusal on your part of my complete written testimony will give you more information and insight into my proposals.

Education contributes to the wealth and quality of our society and without adequate support there will be increased unemployment, welfare, crime and incarceration of our citizens.

Professor John Bormuth of the University of Chicago has stated that for every dollar spent on education there are six dollars added to our national income.

Here is where we stand today. The time is now to make a commitment for our future. We are at the proverbial crossroads and the path that we choose to take and our decisions we make today will have a profound effect on the future of this country.

We will have to bear the burden of a wrong decision. We, as teachers and educators, cannot do it alone. It is up to the public and the government leaders to give the schools some positive support in order to ensure the survival of our freedoms and, ultimately, our democracy.

Thank you.

DR. SEABORG: Thank you.

Our next speaker is Alan Fribish.

STATEMENT OF ALAN FRIBISH

PRINCIPAL, LOWELL HIGH SCHOOL, SAN FRANCISCO

MR. FRIBISH: Let me start by thanking Mr. Pawson for words that I wish I could have said as eloquently. He really put me in a position where I can't follow him.

I am from Lowell High School in San Francisco where I have been principal for the last two and a half years.

Lowell is a school which has had some recent public attention. It is a superb school and it is a model that I would invite you to come and see. It has 3000 students from every part of San Francisco who come there to excel in every one of the disciplines.

The school is a minority school. And the paradox is, the majority of our students come from identified minority groups. Our teachers are students. They continued school, one recently completed his Ph. D. in Chemistry at U. C. Berkeley.

They act as leaders in the college boards, Advanced Placement Workshops, test construction sessions and read examinations. Our students are teachers. They teach each other.

We have a scheduling model which gives them time to work together and they do this, and they do this very well. We have done an excellent job in Advanced Placement examinations.

In the last year, 326 of our students attended 459 courses and they passed at over the 90 percent level.

I would like to call your attention to a couple of things in my remarks. One is the concept of commitment. In 1955 as a young science teacher, I had the rare opportunity of working at the University of California Radiation Laboratory with Professors Harvey and Chopin who published under the name of Harvey, Chopin, Seaborg and others.

It was a marvellous program in the summer of 1955 and served as a model on which the National Science Foundation institutes were based and prospered.

My entire science and math faculty have been influenced by these institutes and they have been the source of inspiration for them in their teaching.

I have some concerns that I came to speak to you of today. The first concern is funding. Jerome Bruner in his little book, The Process of Education, states, "A student learns science only when he acts as a scientist."

He acts as a scientist only when he has the materials of science at his hands. Those materials cost money. He needs supplies for every day. We have to replace the existing equipment. And we need to enter the technology of today.

I regret to tell you that Lowell High School is not now in the computer age in a significant way. We recently had a conference of the principals of 12 schools which were identified by a national magazine as 12 top schools -- 12 top public schools in the country.

When the principals came together two weeks ago, the first thing that was said was, these schools are not alone. Each of us can point to a handful or a double handful of schools in our communities which have a level of excellence which is comparable. There are excellent public schools all through the country.

The second thing that came up was our concerns about our teaching staffs. There has been a competition from the private sector, of industry, for teachers presently teaching science and mathematics. They have offered them inducements -- financial inducements, that have not been able to be matched by the schools.

I would caution the industries that they are -- to borrow a metaphor from a friend -- eating their seed corn. We will not be able to produce the people that they need in the next years if they continue to steal from us.

There has been a dearth of teaching candidates for precisely the same reason. People are not coming into education when Fairchild can offer more than can Lowell High School. We have had accelerating retirements from Lowell High in San Francisco and the Bronx High School of Science as well, and schools in between. The concern was the same.

Mr. Dederian had some ststistics here today, and I did a rapid summation of them. The average age of teachers of science in San Francisco is 47 years. Fifty of 131 are at age 50. They will be retiring when their replacements graduate from college if their replacements enter college this fall.

There is also a phenomenon called the echo boom, the baby boom of the fifties. This produced a boomlet which is coming along. We are faced with the intersection of a whole bunch of lines which cause me great concern.

If we are going to replace these teachers, if we are going to find what we need, there must be the type of commitment that existed in 1955 when you helped me.

Thank you.

DR. SEABORG: Well, I thought you looked familiar, but I guess both of us have changed in appearance somewhat.

MR. FIBISH: You haven't.

DR. SEABORG: Also I would like to make the comment that I serve as one of the judges for the science talent search every year. I have for years. And the performance of students from Lowell High School has come to my attention -- maybe not quite at the level of the Bronx High School of Science, but certainly one of the best high schools in the west.

MR. FIBISH: Yes.

DR. SEABORG: Thank you.

The next speaker, speaking for Edward Foglia, will be Juliet R. Henry.

STATEMENT OF JULIET R. HENRY

CALIFORNIA TEACHERS ASSOCIATION

MS. HENRY: Thank you, Chairman Seaborg, Commissioners and audience. I am Juliet Henry. I am a teacher in Los Angeles.

For years, the last 17 years, I taught elementary school, regular classrooms at first, then math only for about six years, to fifth and sixth grade students.

I became a math coordinator, a Title I Coordinator whose major responsibility was to staff development and inservice. And right now, I am a math teachers in junior high school.

But I came to you today representing approximately 200,000 teachers in Los Angeles. The California Teachers Association testimony is not aimed at improving mathematics, science and technology, but much more, including student experience in the humanities, the practical and fine arts, career and vocational education and physical education.

We applaud the stress on science, mathematics and technology and the many ideas expressed here today. But the non-science curriculum is just as vital as producing scientists and other technical persons.

Some of the obvious skills are writing and drawing. These and other noteworthy skills are necessary to scientists and technicians to communicate their ideas to professional and lay people. That is an obvious point.

But what may not be obvious is the need for financing and currently, additionally, improving the non-science curriculum. Because improving the teaching in the science and technical curriculum will require writing, art -- physical and practical art skills, and broad philosophical points of view about science and non-science.

The non-science curriculum may not appear to be of equal priority, but it is. I know of an artist in the valley who works with engineers to illustrate their ideas because they do not have the skills or the capacity to illustrate their own ideas.

Newspapers carry stories and advertisements about writing consultants whose prime activity is to teach scientific personnel how to write more clearly.

Our suspicion is that the increase in the public dollars spent for science, mathematics and technology will not be matched in deed, that the increase may be at the expense of non-scientific curriculum.

Recently, some of our representatives talked with staff from Governor Brown's office about staff development in computers, math and science. We are talking about approximately $49 million, $11 million dedicated to staff development. This is an increase in educational spending.

The Governor dedicated nothing extra to the non-scientific curriculum. We sense this will be the direction for others to follow because industry and business have a voracious appetite for trained mathematicians, scientists, engineers, technicians and experts.

We believe the public schools are the major suppliers of that kind of brain power for universities, and in turn they are major suppliers of professional graduates for the career or the work world.

We are interested in supplying in business terms students who eill think and speak about the social issues affected by science. Science is loaded with values and points of view about the social world, but they are often expressed better in historical, literacy and artistic ways.

We are sure you have heard this balanced curriculum argument before. We want the argument to remain in your minds constantly. We want you to be vigorous about expanding the minds of our young scientific students into the non-scientific school curriculum and to help us to make non-scientific curricula vigorous and applicable to elementary and secondary science students.

The extra dollars spent in the non-scientific curriculum will build that necessary context to generate vigor.

We believe money for staff development for mathematics, science and technical teachers in California should be channeled into teaching centers, federal and state, and to staff in school districts during the school year.

The legacy of the National Science Foundation is rich but we have not forgotten how strange it was to be one of two or three people who received the extra knowledge, because only a few were chosen to be trained.

We believe training must occur during the school year as well as in the summer. We believe there should be a significant number of dollars in the training account for individual teachers -- perhaps $1,000 to start each training account.

It is not uncommon for a weekend workshop to cost about $350 for registration only. Schools will also have to invent circles of practicing teachers to share their expertise. Often the experts needed live at home, but the organization of public schools is designed to keep everybody's nose to the grindstone interacting with students, with little time left to share the expertise they have of either the students or the content.

All of the preceding require money. Most informed people close to education know that money must be spent to improve teaching instruction and the curriculum. But few chose to fight over the delivery of stff development for a variety of reasons.

The number one reason being the waste of tax dollars. That is, spending money on teacher training after they have been trained.

Or the number two reason, teacher training gives teachers more responsibility.

Our reaction is to present reason number one and two to any major corporation in the United States as reasons for rejecting employee training and they would laugh at the faulty reasoning, for retraining employees is one of their major responsibilities. Business and industry recognize that trained people generate profit.

We have followed the work of this Commission. We understand that the Commission has five more hearings on different topics. We know this topic, staff development, inservice training, teacher evaluation -- whatever you want to call it. The constants are clear.

Any change, innovation, addition and deletion in the educational process requires the affirmation of teachers. The emphasis should be placed on staff development.

All teachers need to be trained. All teachers need to be paid more. The elitist position of paying math-science teachers more can generate an elitist idea in the mainds of math teachers.

We would like to say thank you for allowing us to present our ideas here today.

Thank you.

DR. SEABORG: Thank you.

The next and the last speaker is Jess Bravin.

STATEMENT OF JESS BRAVIN

STUDENT MEMBER, BOARD OF EDUCATION, LOS ANGELES

MR. BRAVIN: Mr. Chairman, Members of the Commission, staff and guests, good afternoon.

My name is Jess Bravin. I am the student member of the Los Angeles City Board of Education. My remarks today basically expand on those in my letter to you last month.

I don't have any studies to quote or experiments to cite, and my highest academic degree is a junior high school diploma. Nevertheless, I do have some perspective as the representative of a million students in the Los Angeles city schools.

In speaking to students throughout Los Angeles, it appears that the subject found most distasteful by teenagers is mathematics. There is no question that math in the lower grades is absolutely necessary. Further, there are some students who take naturally to mathematics and abstract thinking at all levels.

But for many students, even those labaled high achievers, it is often unclear why higher mathematics should be studied at all. Students are often displeased in other subjects as well. But this uncertainty about the purpose of study is not nearly so definite in English, social studies, foreign languages and other disciplines.

Teachers themselves seem vague about the reasons for studying higher mathematics, and I speak of algebra and geometry for high school students.

Students pursuing careers in medicine, engineering or related areas know that advanced mathematical study is necessary for those fields.

But for the rest of the students, math teachers can only say that somehow math makes you think better, or will help you better deal with the technological world.

I admit clearly that this is true. And exposure to abstract and conceptual thinking is clearly beneficial to many young people and increasingly necessary in the world.

Somehow though, the claim that it makes you think better is hardly a motivating factor for students. Adding this to the rotework that is necessary for the study, the result is classrooms full of students uneager to learn math.

Many students are clearly indifferent to higher mathematics. And inspite of programs mentioned here today, most teachers mainly seem to replace enthusiasm with discipline as the motivating factor in math courses.

There are many educators who call for more math courses without examining the content of those already offered and why they are unpopular with students today.

Now, perhaps strict discipline in the classroom and the meting out of lots of assignments does generate an adequate amount of homework turned in. But education by decree, which is far more from the norm -- at least in our school district -- will very often succeed only in turning off students to math.

Faced with poor math performance, schools seem to be retreating to a stricter, more limited math curriculum that emphasizes more of the same -- work and exercises out of textbooks without supplementary experience.

Rather than perpetrate a system that is unpopular among students and far from being an amazing success, I suggest that math be seen in a new light.

Instead of being presented just as a theoretical philosophy, math should be shown to be more of a demonstrable science -- as many other speakers have suggested today.

Governor Brown and other leaders have echoed a call for better instruction in math, science and technology fields which are clearly related. The fast growing job areas are in engineering and science.

Math education I believe should be expanded to meet this new challenge. Science courses do not rely on lecture and text alone to impart scientific principles. To supplement that, they conduct experiments and generally try to demonstrate science in the world around us.

To treat math more like this, courses would require the use of computers and other devices which can demonstrate math in action.

Instruction would not only be strict axiom, but also involve physics and logic and other disciplines which are inexorably linked to mathematics.

Generally speaking, I think that young people need an education that goes beyond the textbooks to make studies in school meaningful out of school as well.

Further, we want initiative and innovation on the part of students and staff encouraged by the administration of schools and districts. Usually, however, the opposite is true. School districts seem wedded to a tradition that exists simply because it has existed before.

Now, as I mentioned in my letter, students are -- instead of being encouraged to take on new challenges, they are discouraged from taking challenging courses, partly because the marking system doesn't take into account the relative difficulty of courses offered.

In other words, students have nothing to gain except knowledge for knowledge's sake by taking advanced courses or ones which they find more challenging.

The problem is not so great at the college level --

Two minutes?

DR. SEABORG: Two minutes.

MR. BRAVIN: The problem is not so great at the college level where a different number of units are assigned to courses. But in junior and senior high schools where classes are uniformly five credits or one unit, or whatever, all classes are calculated the same way in the grade-point average.

A weighted marking system, as I proposed in that letter, would be one way to alleviate this problem.

I have some remarks in a more general area, that of student participation in educational policy. If there is time later on, I would like to bring those out.

Thank you.

DR. SEABORG: Thank you.

Well, this leaves about 15 or 20 minutes for questions by the panel.

I might start this with a comment. I wish that the 17 speakers this afternoon would repeat their presentations, perhaps a little bit expanded beyond the five minutes, up and down the State of California and throughout the west.

That would certainly advance our cause very much. I don't want to single out anybody, but it appears to me that if John Pawson could be supported and make a speaking tour, I think this would be very good.

(Applause.)

DR. SEABORG: All right, with that, may we have some questions.

MR. FOSTER: Mr. Bell, May I have a question -- with your permission, Mr. Chairman.

DR. SEABORG: Yes.

MR. FOSTER: Mr. Bell, you remarked that you were representing other organizations besides General Electric. Could you describe that for us?

MR. BELL: Industry-Education Council of Santa Clara County is a cooperative effort between the larger industries in the county and superintendents in the various schools to develop programs which are supportive of educational needs in the county.

We have, for example, a multiple computer van which provides computer familiarization for the elementary schools forward. We have just launched a program that is designed to show job-related aspects of high school curriculum in an inner-city school.

We have a number of other projects that are similar -- career passport, which is a way of helping students focus what they have learned in school and what they like to do personally into a resume that is job-oriented to assist them in finding work.

MR. FOSTER: I think Mr. Walker told us about some of his difficulties finding equipment that was absolutely essential.

Does the industry education council give any help in this respect to schools?

MR. BELL: We don't specifically. Our console in the computer van, per se, is equipped with 16 Atari personal computers which have been given to us by the Atari Foundation.

There are loans of equipment. There are individual corporations which on occasion do donate equipment. But this is not a project of the industry council, per se.

MR. FOSTER: But you are aware of the De Anza-Foothill Community College problem? Is this something that is of interest to somebody like your organization, or not? Or will they have to find their own solution to the problem?

We have heard a lot about industry and business becoming more involved in helping as part of the duty of busines to do this.

Is this something that we should discuss here?

MR. BELL: Well, I think it has been a topic that has been discussed, most recently I think about three months ago we heard from the superintendents of two community colleges who said that they needed help, they wanted help.

There were representatives I believe from about 12 different companies that day, all of whom said tell us what it is that you want us to do to assist you.

And as yet, they have not come back to the industry-education council.

MR. FOSTER: Thank you very much.

MS. LARSEN: Is Mr. John Martin of Palo Alto Unified School District still in attendance?

Mr. Martin, in your testimony you speak to an item that I think we would all like to replicate. And I wonder if you can tell us how it is achieved?

And that is that a highly-motivated goal-oriented student body requires a quality teaching faculty if the students are to achieve their aspirations.

I understand you have a good track record. What is particularly in action at Palo Alto Unified School District?

MR. MARTIN: I am not sure I can give you any more insights than I suspect you already have.

Our community is peopled by adults, by and large for the most part, who have been broadly and well educated. They maintain education as a high priority. They have translated their priorities into community support and have insisted that schools and their teachers be good, be well trained, and have assisted the staff in getting student cooperation and participation. The communication between home and school I would say is superb at all levels. I think it is set in that chemistry.

MS. LARSEN: Is your district primarily a neighborhood school?

MR. MARTIN: Yes. It is small and compact. And there is great parent-school communication at all levels.

MS. LARSEN: It sounds very good. You are to be complimented.

MR. MARTIN: Thank you.

MS. LARSEN: Thank you, Mr. Chairman.

MR. SOMMER: I would like to pursue this just a little bit and ask you another question.

MR. MARTIN: Fine.

MR. SOMMER: Do you have any idea of the salary scale of your teachers in your community?

MR. MARTIN: Yes. The average teacher -- well, the distribution of personnel in terms of tenure in the district as you can well imagine -- from other comments that I made -- is very skewed.

People come to Palo Alto and stay. With benefits in our benefit package, I believe the figure this year for the average teacher salary is in excess of $30,000, with benefits.

MR. SOMMER: Would you say that selection of the teachers is based on some sort of exclusivism where they realize that these people have excellent training?

MR. MARTIN: No question. No question about it in my mind. I would say that kindergarten through 12th grade personnel, we were very fortunate in being able to be very selective. It was a marvelous opportunity to pick people not only well-trained in science and math, which is our primary concern today, but even those science and math teachers have brought with them a broad education in the humanities, an exciting thing which the humanities group in this state has looked at with some envy.

Because students come out of those science and math courses keyed to look at their newly-developed scientific skills and insights in a broader context that is very value oriented.

And that, I think, provides a kind of broadness and intensity that we are looking for, over and above just their technical knowledge and skills.

MR. SOMMER: So we can conclude that one can find good teachers in spite of the bad things we have heard about education today?

MR. MARTIN: I would hope so. If I had been more attentive to time, I would like to have spoken in greater detail. As I tried to say very hurriedly, my great concern rests in what I believe to be the fact that the same kind of people who presented themselves for training in the late 40s and early 50s are not for obvious reasons presenting themselves for teacher training at the current moment.

And my great concern is not that Palo Alto Unified School District would not be able to fill existing vacancies, but that they will not be able to fill them with the qualifications that thei predecessors brought to the task.

MR. SOMMER: Thank you.

MR. GARDNER: Mr. Chairman?

DR. SEABORG: Yes.

MR. GARDNER: Is Juliet Henry still here?

There were two comments in your testimony I should very much appreciate your commenting on.

One had to do with concern -- if I am paraphrasing this correctly -- a concern that an emphasis on mathematics and science would tend to draw resources from other parts of the curriculum. In other words, it would imbalance the relationships among the students.

My first question is, if that is a correct statement, are all programs offered in the schools of undifferentiated significance? That is the first question I have.

And the second question has to do with what I took to be an unsympathetic regard for differentials in salary based upon discipline.

Do you believe there is any basis for any differentiation in salary whatsoever, other than longevity, irrespective of discipline or perceived ability?

Those are the two questions I have, which are not easy but I would appreciate your comment.

MS. HENRY: Number one, the California Teachers Association has always been committed to a single salary schedule, because we do believe that all of the teachers are important, and that the teaching profession itself is in need of a financial upgrading, and not just one section of one department or one curriculum area.

And if you grant additional income or additional salary differential for the math-science area, then this can create an elitist idea, a notion in the minds of many teachers at the sacrafice of other teachers.

And what we are saying is that the other teachers who teach the other subject areas are just as important to a balanced curriculum for our children as math and science.

MR. GARDNER: Putting aside this question of whether you can differentiate from one discipline as against another, do you favor any differentiation of salary based upon perceived ability and competence?

MS. HENRY: Well, most teachers, after returning to school and receiving additional credits in a school, do receive additional income. Our position on that is that you have earned those credits and you deserve the differential.

But just paying a teacher a differential because they are teaching a different subject is a major concern of ours.

MR. GARDNER: The first question then, which I may not have raised properly, had to do with the shifting of resources to math and science which may occur. There is that emphasis on it.

MS. HENRY: We are not saying that emphasis should not be placed on math and science because we do believe there is a need for emphasis.

But we don't want to sacrafice the other areas while we are placing all the emphasis on math and science today.

MR GARDNER: Do you regard that any one area of the curriculum is more significant than any other area?

MS. HENRY: For a totally well-rounded student, we believe that all of the areas are important.

MR. GARDNER: Equally important?

MS. HENRY: Equally.

MR. GARDNER: Thank you.

GOVERNOR QUIE: May I piggy-back on that a little bit?

I understand what you said on differentiation in salaries. What about special emphasis on programs for instance, in special education?

In recent years, there has been special emphasis on those programs, special attention to them. And the feeling of many of us is that if just left to being treated like everybody else, they would probably be on the wane. They need some special attention outside of the school district.

MS. HENRY: Unfortunately, even being treated specially, some of them are on the wane.

GOVERNOR QUIE: Well, that may be. But if they weren't to be treated specially, does your organization feel that there is anything that goes contrary to your policy to treat them specially?

In Minnesota, some of the people in the Minnesota Education Association have been critical of the special attention given to special education because this has caused some classroom teachers, if they have an opportunity for a job, to go to extra training in special education.

MS. HENRY: Our organization does not want to mitigate the importance of special education or any other curriculum area.

What we are saying is that the total curriculum is important for the total development of the students. And when you place undue emphasis on any one part of the curriculum, many times the other part is sacraficed, such as reading.

If you are going to place all the emphasis on math, there is the possibility that reading could be sacraficed, that art could be sacraficed.

What we are saying is that all of these are important as far as training our future citizens for tomorrow.

GOVERNOR QUIE: Well, I think it is important because teacher organizations have quite a bit of political clout.

MS. HENRY: Thank you.

GOVERNOR QUIE: We talked this morning that there has been a change in emphasis on math and science since the end of the 1950s. And I recall listening to teacher organizations say that should not be a special area of attention. And the same thing you say for balance, you need all the other parts of the curriculum.

As a result of that, if that political impact did make a change -- and now we are coming back to science and math being shorted in schools. Do they need special treatment like special education in order to provide for our needs for those who otherwise wouldn't receive it?

MS. HENRY: Well, I am not sure that that is the result of that. As a member of one of those groups who participated in the National Science Foundation science and mathematics program in the late 60s, the math for elementary school teachers, math specialists, and all of that, the emphasis then was placed in this area for a short period of time, and the long-range need was ignored.

Long range needs are sacraficed for short-term needs and I think this might contibute to some of the problems which we have today. If we had thought in terms of long-term needs along with the short-term needs, we might have been able to generate more teachers.

However, we all know that the space industries in the 1950's contributed a lot to that. They have contributed a lot to the position we are in today.

MS. GORDON: I believe Nancy Kreinberg is out there?

At the conclusion of your remarks, I believe it was about signal time, you mentioned the concept of parent education in which students and parents would learn together.

I wonder, have you had experience with this? What sorts of approaches are being used?

MS. KREINBERG: Well, we have started a program in Richmond, which is a high minority community a little bit north of Berkeley, called "Family Math," where we have parents and children learning mathematics together.

The point being, to do two things at once -- have parents learn how they can help the children, and also have parents acquire some math skills themselves.

This is the first year of the program. It is funded by FIPSI in the Department of Education. And we started with about 25 parents and their children at the K-2 level. We finished that sequence of courses and we are now starting with a similar number of parents and children at the 3-5 level. We will end up this year by working with parents and their children at the junior high level.

In addition to the math, we also have at least one evening in which we have the parents bring their teenage children and hear from role models, men and women in the community who are working in scientific and technical fields, so they can relate the math that they are learning to future dialogue opportunities.

It is a pilot program and we are learning a lot. One of the questions is whether it is better to teach parents and kids together or separately. So we have two kinds of programs. One was with the parents alone and one with the parents and their children. And we haven't drawn any conclusions yet.

But it is an interesting program. If we don't get refunded, it will not return.

MS GORDON: We talked about students and teachers. And I keep wondering what the role of the parent is going to be as we try to improve the quality of education.

Thank you, Ms. Kreinberg.

DR. SEABORG: All right. Well, I think we should take our 15-minute break now and come back promptly at 4 o'clock.

(A short recess was taken.)

DR. SEABORG: We are going to proceed as we have this afternoon. Five-minute presentations of those who have asked to be heard to make their contribution.

And the first person will be Frank Oppenheimer. And each of you should introduce yourself and tell us your connections, and so forth.

Mr. Oppenheimer?

STATEMENT OF FRANK OPPENHEIMER

DIRECTOR, EXPLORATORIUM, SAN FRANCISCO

MR. OPPENHEIMER: I am Frank Oppenheimer. I am the director and founder of the Exploratorium in San Farncisco.

I have also taught on a great variety of levels, at the University of Colorado and at several other places. I have taught graduates and undergraduates. I have also taught high school, and developed science curricula at the junior high school and the elementary school level.

But about 13 years ago, I felt that one needed a place where all students at all levels could get familiar with the processes of nature and develop intuition about them, and perhaps have a place where teachers and parents and children could all use the props together.

So we have set up about 500 exhibits arranged in a series of interlocking curricula. That will grow to around 750 in a few years. The place is attended now by around 450,000 people a year, of which half are adults and the other half are under 19. About a quarter of our visitors are under 10.

It is certainly the most rewarding form of teaching that I have ever done. And I think it is a necessary part of the overall education establishment to have such places. Science centers have been growing all over the country, in fact, all over the world in the last 10 years. And our organization has found that it takes an interest in coordinating what we have to do with what others are trying to do.

One of the things that I really appreciate, Dr. Seaborg, is the difficulty of what the Commission has to do. One of the things about education that I have found is that almost everything that anybody says about it is true.

But that, I think, does not reflect the great richness that is needed for teaching. No one of the avenues for teaching is going to do the job, especially with the complexity of this society and the complexity of what has to be taught.

And I wanted to talk to the Commission today because I think that science centers are such important places. They are a delight too. The schools use them, and we have a great many teacher-training sessions.

We have developed curricula that are useful to the schools. We have developed props that can go to the schools. But in addition to the formal training that we can offer to the school children and to the teachers -- and this is an ongoing thing -- the exhibit teaching materials are here year after year. It is not like something you just hand a teacher.

In fact, some of the teachers who have gone through our workshops have returned and pulled out of the closet some of the curriculum materials developed many years ago. So this is a live teacher-training center to which the teachers can return over and over again.

But another wonderful thing happens. Parents come here and use those props to teach their children, and also to teach each other and their friends. It is a place where all kinds of people come and use the props to do the kind of teaching and self-learning that they would like to do. And I have found this extraordinarily rewarding. It fits in with so much else that is happening.

I wanted to mention that we have tried to do it very economically. I think in the 12 years we have been going, we have spent around 11 million to build these props. And about a quarter of that money has come from the federal government -- very largely from the National Science Foundation, but also very substantially from the National Endowment for the Arts and from the Endowment for the Humanities and from FIPSE in the Department of Education.

This money, this Federal money, has helped legitimize this whole kind of education. I think it is playing that role throughout. And it isn't particularly the curriculum that has been developed through the

National Science Foundation, but the fact that through those efforts the academic community, the university community, became very much more interested in improving science education at all levels.

So that it did represent a national priority, and the only way that you can show there is a national priority is to have some Federal money helping what is going on. I have been disappointed that things look shaky at the moment. But I am sure that in the future it will work out again, and the support will come back.

Science centers have been spreading in this country. They occur not only in major urban communities, but also in many smaller ones. And therefore I think they can play, in all these places, a very substantial role in improving education.

Schools cannot do it all by themselves. People have complained that schools have been asked to do too many things. But I don't think those jobs, are going to be taken away from the schools. I think that what has to happen is that one has to begin to view public education not just as school, but as a conglomerate of adjunctive organizations which include museums and libraries as well as television programs. I think all of these must play an extraordinarily important part in education.

And here the emphasis has been today. I have heard so much on the schools. But I think if the Commission doesn't consider all the facilities that can help education, there is no way of turning around some of the difficulties that people have pointed out are happening in the schools.

Thank you.

DR. SEABORG: Thank you.

The next speaker will be Leigh Burstein.

STATEMENT OF LEIGH BURSTEIN

GRADUATE SCHOOL, UNIVERSITY OF CALIFORNIA, LOS ANGELES
ASSOCIATION, CENTER FOR THE STUDY OF EVALUATION

MR. BURSTEIN: Thank you. My name is Leigh Burstein. I am at the University of California at Los Angeles in the Graduate School of Education, and I am associated with the Center for the Study of Evaluation there.

I am in part speaking in my responsibilities for that job. And also I have some personal views that are as yet unfinished.

My colleague and I are in the process of developing an opinion for the L. A. Times, something unusual for us, dealing with the problems of pre-college math-science instruction, the teacher training problem, and the teacher shortage problem. And I thought I might share some of our as yet unpolished ideas with this group.

A couple of observations to begin with. Even if all of the money that was put into science, math and technology education in the late 50s and early 60s were available today, even after adjusting for inflation, that it would not be enough to solve the pre-college teacher-equipped shortage and talent problem.

The issues are just more complex today. The need for citizens to have a certain degree of technical literacy today are just much greater.

Second, the nature of hte economic conditions at present and governmental directions, federal and state adjustments in education in general, makes it unlikely that we will get these needed resources devoted to education strictly out of federal, state and local government offers. Certainly not in the magnitude that is needed.

This leads to my third point. If we can't get the money directly from the federal-state governments as we have in the past, it seems to me it is time to think more seriously about tapping the enormous potential for industrial cooperation in dealing with this problem.

We will need industry cooperation and investment to deal with what I consider three problems.

One, Income levels of teachers has both an economic and a psychological impact on skill levels. And there has been a lot of discussion of that.

Another thing that is not part of the pre-college teacher training and equipment shortage problem but is very relevant to industry is the problem that technology is facing in terms of professional burnout and retention of highly-skilled and trained engineers in the jobs that they are currently employed.

I think that the private sector can make a significant dent in math and science instruction deficiency in the secondary education. At the same time, they can contribute to reducing their own problems with employee burnout and retention.

With renewed university pressure and parental awareness and support, students will begin to take more math and science courses in high schools if there are sufficient skilled teachers and equipment. But not enough college students are being trained to teach math and science and there are neither incentives nor resources to redirect teachers from oversubscribed fields into these areas.

The private sector's role in solving the teacher shortage can be that of an investor and an educator. Since the three main reasons in my view of the teaching shortage are economic -- teachers don't make enough money to maintain the middle-class existence -- intellectual and psychological -- the whole notion of the professional status of teaching has eroded over the years -- it seems like industrial investment can begin to help solve these problems.

The mechanism we propose, which is very sketchy at present but will be elaborated later, goes something like this.

The mechanism for private sector contribution is through support, either direct or indirect, of ongoing math, science and technology institutes for improving teacher skills or retraining teachers from other subject areas to enter these fields.

The institutes would be somewhat akin to the programs formerly sponsored by the National Science Foundation. The purpose of the institutes would be to provide improved up-to-date knowledge of science and math computing for present teachers and for teacher transfers from oversubscribed fields.

Second, but I think in some sense more importantly, industry can provide income supplements through institute stipends and fellowships to augment teacher earnings, and provide teachers with the opportunity for part-time work in the private sector for further augmentation of earnings and better awareness of industrial applcayions, with the possible benefit of improved relevance of teaching and better career decision making.

And in the case of year-round institutes, not just summer programs, these programs can provide opportunities for additional part-time -- and I put this in quotes -- "consulting" for teachers, many of whom are already working a second job to maintain their standard of living.

The institutes can also serve to partially alleviate the industry's problem of employee burnout and retention. Volunteers can be offered release time or paid leave, to serve either as the instructors in the institutes or with special exemptions from the credential regulations, as part-time teachers in local schools and colleges.

The teacher's part-time consulting through the institute will partly offset the lost personnel, time and with lower costs in terms of salaries and benefits, than actually hiring additional full-time employees.

Returns from this investment are both tangible and intangible, long term and immediate. If the institutes were successful in providing financial and motivational incentives for retaining teachers, preparing them to do a better job, encouraging a higher percent of the talented students to enter the teaching profession, while at the same time reducing problems with employee burnout and retention, then this investment could be in the industry's self-interest.

Each retained teacher, each recruited teacher, makes available a person who can handle another 150 high school students at a time when industry wants more technical skills.

Other tangible benefits are the use of lower-cost part-time teachers assistants and consultants -- quote, teacher assistant consultants -- to cover shortfalls in staffing and relieve highly-skilled employees for more creative duties.

Thank you.

DR. SEABORG: Thank you.

The next speaker is Judy Chamberlain.

STATEMENT OF JUDY CHAMBERLAIN

GIFTED AND TALENTED PROGRAM TEACHER, CUPERTINO

MS. CHAMBERLAIN: Chairman Seaborg and Members of the Commission, thank you for the opportunity to put some input in from the front-line trenches.

I am an elementary school teacher who is teaching with the Gifted and Talented Program in Cupertino Unified School District and teaching computer awareness to second graders and up.

I started in 1977 not knowing the difference between a microchip and a chocolate chip.

I moonlight for the industrial education council that you heard about earlier that has the computer van that goes to schools and so forth. And I also teach a class that we found was desperately needed in our district for parents, called "Computers Without Trauma." So that they could speak "computerese" with their children. Children were coming home speaking a language that left parents feeling a little behind.

The Cupertino school district has at the moment an enrollment of 12,000 from kindergarten through eighth grade. I was very pleased today to hear a large number of speakers refer to the importance of elementary education. That is where the action is.

I have second graders who tell me, "I hate math."

But I watch those same children enjoy challenging problem-solving activities when they don't come out of the math text. We need to change the way students perceive mathematics and we need to change their attitudes early. And we can do that.

Our district, in the heart of Silicon Valley, is good. We take pride in being an excellent school district, and I think I could give you perhaps three reasons why that is true.

First is that we have an effective partnership among parents, teachers, administrators, and the school board trustees. We all work together very well. In fact, sometimes our legislators are taken aback when we appear before them as a unit and ask to be heard.

Second is the excellent staff development program within the district. We discovered a few years ago that declining enrollment means you can't hire new teachers. That means we could no longer depend on an annual injection of new ideas and enthusiasm and we needed to look for other ways to keep our staff professionally up to date and innovative. With participation of teachers, administrators, parents, and trustees, we developed an inservice program that is excellent. It provides all kinds of carrots to get people to do things and improve their skills long after salary improvement is possible.

The third element is that we have had federal seed money for innovative projects. We also have money from the state in the form of the Gifted and Talented Education funds. These outside funds have enabled us to get things going in our district that would not have happened otherwise.

And I am a little worried when I look at the future.

I would like to give you a couple of examples of things I think got started because we had start-up money and which have now been assumed by the district and are going well.

One of these, of course, is the computer program in the district. It was developed with a combination of federal Title IV(c) and state Gifted and Talented funds. It now extends to almost every student in our district. By the end of next year, it will be every student in the district. And I am talking about kindergarten to eighth grade, Gifted to Special Ed. Over half of the teachers of our district have had at least one course in computer literacy. And I am talking about 800 teachers. So we are advancing and learning and doing what we need to do.

Another thing that began in our district because of start-up money is an environmental education program for elementary school students, again starting at kindergarten level. It began as a project with outside funding; a curriculum was written for each grade level and it's being used throughout our district. We also have an energy conservation program which involves students as well as classified and certificated members of our school district in learning what we can do to conserve energy on a practical basis within our own district. And I am sure this appies to their lives outside school.

We have a pilot project in economics going on this year at one junior high school. This appears to be a good level to begin a more thorough study of this subject.

We have a program on human health known as Berkeley Health Project, which enables students to learn more about themselves, beginning at an early age. This hands-on science has proved a more effective approach than reading it in the book.

Now, all of these things need leadership and they need financial support. And I am worried about the strong possibility that help is not going to be there in the future.

You won't very often hear teachers stand up and say we want more administrators. But I stand here and say that we need to have an organization like the Department of Education that says to the nation and to the world: Education is important in this country!

We need to have leaders in state capitals. We need leadership in those special fields such as the Gifted and Talented. In California there is a real danger that we may lose the Gifted and Talented Education management team and local coordinators as well because of a lack of funding.

You have the opportunity to take what you have heard today and the information you'll be receiving in the future hearings and use it to make things happen in education. As I listened to you today, I felt you were with me.

I wish you good luck. We all need your work.

DR. SEABORG: Thank you.

The next speaker is Michael Summerville.

STATEMENT OF MICHAEL SUMMERVILLE

FREMONT UNIFIED HIGH SCHOOL DISTRICT

LOS GATOS JOINT UNIFIED HIGH SCHOOL DISTRICT

MR. SUMMERVILLE: My name is Mike Summerville, and I am here today to represent two high school districts in the middle of Silicon Valley, Fremont Unified School District and Los Gatos Joint Unified High School District. Cupertino Unified School District feeds into our district.

So you can see that we are getting quite a product from our elementary and senior district in terms of computer awareness.

The two school districts are embarking on a rather unique venture which I would like to share with you today. And it was suggested by Governor Brown's staff for us to come to this Commission to speak about this concept. Because it encompasses several of the components that he has included in his "Investment in People" proposal.

We are embarking on an Institute for Computer Technology, which is to supplement the regular curriculum in both high school districts in the area of high technology instruction.

We see that even with the equipment we can purchase and make available to all of our high school curriculums in the entire area of math, science and computer technology, that there are specialized teaching skills and specialized environments that we need to be able to provide for a segment of our students that high schools cannot expect to generate out of their own sources.

Therefore, we are starting a venture in September of this year which involves not only two school districts working together to establish a common facility which breaks down the boundaries of attendance between the two school districts for schools, but also it is a merger of the two districts and industry people who are involved in the venture.

We are meeting with our local high technology industries in the area right now to talk about this venture and saying to them that many times they see curriculum needs from the high school students that high schools are not providing.

And we don't know exactly what they mean in thos curriculum areas. We are meeting with them now to define curriculum that will be part of our venture that starts in September. That curriculum will be developed jointly by the members of the semiconductor, electronics and computer industries in Santa Clara Valley, and our districts, and will be offered to high school students starting in September.

The importance of having industry merge with us in this venture is that they can supply us with the intended product needs, not only for students who could enter into their industries and their firms when they graduate from high school, but we also have industry working with us to define the longer-range needs -- the engineers and the scientists and the computer specialists that they need.

And we are going to have as part of this institute, curriculum to take the very gifted and talented and motivated students who are involved in computers and electronics, and give them a specialized education using industry-provided equipment and teaching expertise to prepare them to either go on to college and maintain their interest as they get to college, or to give them the option to go on into industry immediately out of high school and be qualified for the technical-skill job areas that are available to them in great numbers in our country.

We feel that part of this program will be an extensive work experience program and a summer internship program for the students to take part in the industries to earn a little bit of money.

But more so to be able to use the skills that they are getting in course work in the schools out in real life as part of an industry setting.

In addition, we see this institute providing course work for students, adults in the area, handicapped students, and all segments of our community. So that not only are we meeting the needs of our 18 and under year old students, but also offering training and instructional programs for adults in the community who may want to enter those particular areas and get some instruction.

We also are expecting that a teacher center for training will be part of this institute so that our existing teachers that are in our school systems now will be able to obtain more background and more skills so that they may themselves be qualified to teach in some of these more technical areas.

We feel that the benefits of this kind of merger between industry and education will work. And the demonstrations that we have received back from the business industry people in our area are verifying that.

They are willing to come with education and go into a joint venture if education has its act together and is willing to work with industry on industry's basis.

We feel that some of the benefits are not quite so obvious -- one is the ripple effect of this curriculum. While we have this model going in this school providing technical skills to students, we see our own teachers in our own programs in all of our high schools being able to receive the benefit of that instruction.

As we give technical instructions, say in electronics, at the higher level, we expect that the electronic instruction at the basic level which is provided in all high schools will receive that ripple effect at the higher level instructions so that all of our basic programs will be enhanced and the level of instruction will be improved.

So, this model will not only benefit our students in the specialized situation, but pervade itself out through the community and through our regular teachers and programs in the schools.

Lastly, we expect to provide a demonstration site for computer-related innovations that are taking place, and electronics innovations, in a setting where our community and our schools may bring students in to share in the advancements that are taking place right on our doorsteps.

So I would like to say to you that I think that this kind of a merger between industry and education is very possible, and that industry will buy into it if we give them the right kind of buy-in basis.

We are attempting to create a model which will show that kind of leadership.

Thank you.

DR. SEABORG: Thank you.

The next speaker is Ted Perry.

STATEMENT OF TED PERRY

SAN JUAN UNIFIED SCHOOL DISTRICT

MR. PERRY: Mr. Chairman and Commission Members, I feel honored to be permitted to testify.

I am a psychologist and I am working with a computer program project in the San Juan Unified School District in suburban Sacramento.

Our school district has 50,000 kids on 150 computers. I would like to give you another way of looking at technology as used in the school.

I have heard a lot of things here today and I believe about 99 percent of them. I am not sure that I agree with all of the outcome or results therefrom.

We have heard today of the need for improvement in math and science in the classroom. Who could disagree?

We have heard today about the amount of influence the elementary teacher may have over the future of the children in her class relative to math and science later on.

And then we have heard that some of these teachers are not all that comfortable with math and science and technology. And heaven knows, I have seen that is true.

We have heard the future scientists and the masses need to be computer literate. They need to be math and science literate to some level. Everyone needs to be. The scientists need to be very literate, but the masses need to be able to deal with the technology that is here.

All right. And the results that I hear being presented again and again are that what we need to do now is focus our attention on the math and science classes and the math and science specialists in the school system.

It feels to me like we are missing a piece. If we are asking to educate the population, the masses, are we going to do this by just having specialized teachers, educate and literate themselves?

A little bit of hte direction we went in our district. Through Title IV(c) project, funding that is going down the tubes, we were able to start and build a computer-authoring system.

In other words, a way that normal human teachers, as opposed to programmers, could put their own lessons into a computer system instruction format. And we have, again, normal human teachers, not just the science and math teachers, but teachers who were trained in English or in art or in -- you name it.

They are building lessons for their students and they are using the equipment and they are understanding some of the technology. But in fact it is being used on a day-to-day basis.

The authoring system, the project was finished two years ago and it is currently being used in over 1100 school districts throughout the United States and Canada.

We think that the technology needs to be brought to all of the educators, not just for the math and science teacher.

Please don't misinterpret. I am saying that you should not focus on math and science. I think that it is very much needed. But I do think the general population of educators need to be focused on.

I am concerned as schools within my district call me and are about to being in a computer system -- I said we have 150 computers, but we have got 74 schools and 50,000 kids. So really the number of computers per kid is not that much.

And they say we are going to bring in computers into the math and science department. And I know darned well in many of those schools the English teacher will never appear in that department.

And I am pushing to make the computers appear in a neutral territory. How about the library, the media center? And how about giving the training at the same time to the English teacher as to the science teacher?

Governor Brown has recognized the need for intensified studies in the area of math and science and computer technology in his "Investment in People" program.

I was working originally in a deaf and hard of hearing program with kids that are very high risk. The average deaf adult reads at about third or fourth grade level. And they aren't very well motivated because English is not their language. And it sure as heck is not easy for them to translate from sign to English. It is a whole other world.

These teachers are basically English teachers with special ed backgrounds. At the end of the project, the teachers said to me -- in fact, we put it in the State report -- "I don't understand this. I mean, yes, I built these lessons but they're not games. This is drill and practice language facts, the hardest things for these particular kids to do. And they are fighting for time on the computer."

I think we need to bring technology into education, not just the math and science department. I have said it before.

Funding is needed to provide this training, to provide equipment and to provide education. The San Juan District stands ready to provide some leadership and some help in this direction.

General literacy is what I think is needed. I will leave you with a copy of our documentation.

Thank you.

DR. SEABORG: Thank you.

The next speaker is Paul Hurd.

STATEMENT OF PAUL HURD

PROFESSOR EMERITUS, STANFORD UNIVERSITY

MR. HURD: My name is Paul D. Hurd, Professor Emeritus of Education at Stanford University. My area of scholarship is science education.

My comments today are directed toward a revitalization of the pre-college science curriculum. It has been referred to my several speakers. And I would like to offer my perspective. There seems to be little question but that we are at a turning point in the human venture largely influenced by the interactions of science, technology, and society.

The influence of science and technology on human life and living makes instruction in the sciences imperative in general education.

The present status of pre-college science teaching in the United States is not in harmony with the cluster of activities that relate the natural sciences and technology to social progress.

Although science and technology together are responsible for much of the cultural uniqueness of America, and serve as agents of social change, they are overlooked and taught without reference to human affairs or competent citizenship.

Increasingly, citizens are called upon to make decisions and support policies which may serve to influence the course of human well-being and the quality of life. Many of these decisions demand an understanding of 1) processes for generating bodies of knowledge that are science; 2) the powers of limitations of scientific procedures and scientific information; 3) the social impacts of science and technology; and 4) values, ethics, and perhaps morals.

This is not the context in which pre-college science is taught, although nearly a thousand colleges and universities have in the past decade developed courses or programs along thse lines.

Typically, pre-college science courses represent a system for acquiring a large fund of specific facts classified by broad disciplines such as biology, chemistry, physics or earth science.

Only minimal attention is given to conceptualizing the information. The criterion for the selection of subject matter is that the information is historically representative of the "structure of a discipline."

Recent advances in science and technology simply add to the thickness of a textbook.

I take the position that for effective citizenship, an education in the sciences should extend beyond the acquisition of knowledge and include the means for its utilization.

Linking science as a knowledge-producing system with society as a knowledge-producing system is the challenge confronting science education.

Excellence in terms of science teaching is the attainment of scientific and technological enlightenment.

I think the time has come to stress the roles of science and technology as instruments of service for resolving science-based social problems, promoting the welfare of individuals, and shaping in positive ways the future evolution of human life.

The central goal of an education in the sciences, as I see it, is the one identified by Francis Bacon (1620) in his statement,

> "The ideal of human service as the ultimate goal of scientific effort."

Alfred North Whitehead in his essay on The Aims of Education comments,

> "If knowledge is not usable, what is it?"

Thank you.

DR. SEABORG: Thank you.

The next speaker is Elizabeth Karplus.

STATEMENT OF ELIZABETH KARPLUS

MORAGA HIGH SCHOOL TEACHER

MS. KARPLUS: My name is Elizabeth Karplus and I teach at Campolindo High School in Moraga. We have many excellent science and math programs including advanced placement courses and an excellent program in computer literacy which is a part of many sections of Algebra and Geometry classes. I invite you to come and look at these and other subject area excellent programs whenever you have time.

I am speaking in three capacities. First, as a recently retired school board member dedicated to supporting a broad educational program for all children. In this capacity I second Mr. John Pawson's remarks and list of needed supports, financial and legal, which would make it much easier for school boards to aid teachers in providing excellence in education. We certainly need to posses basic financial information on more than a one year basis to do this. For example, it is ridiculous to send lay-off notices in March to competent dedicated teachers we would like to retain because the Board does not know what its financial resources will be until July or August.

Secondly, I am a high school science, math eatcher who has become in the last ten years a high school special education teacher. In this new capacity, I have found that math, science and problem solving materials are the best learning materials I can use for remediating and for furthering skills applicable to all subject areas. They have status with the students, provide motivation, and are simple enough logically so that almost all students can understand them. Because the number of symbols used are relatively few and the rules for manipulating those symbols clear, they can also be used to remediate reading or listening skills the students may lack.

Thirdly, I am also speaking as a parent of seven young men and women and as a grandparent of seven young children. In this capacity I am worried about the future of the world today. My remarks here are a little redundant to Dr. Paul Hurd who just preceeded me.

I wish to recommend that the Commission schedule another hearing on Excellence in Education in the areas of history, culture and citizenship. If the science and mathematics program is to succeed in its aim of training of professional and productive scientists and mathematicians as well as improving scientific literacy in the whole population, the math-science program must be integrated with other experiences and understanding of the students. As Julliete Henry said, "the math science curriculum should not be out of proportion to the rest of the curriculum."

Today the world is a small place. We all need to know something of geography, history, economic concepts, political realities, as well as differing customs of the places, people and governemtns of the world. I believe the mathematics and science curriculum, in particular, can be an excellent place for students to learn some of this global information. It is also an excellent place to train students in the analysis of variables and analytical problem solving which can help citizens evaluate information that receive from newspapers, T.V., speeches or conversations with friends.

I believe that some of the most powerful educational programs are those where students and teachers can integrate their learning with their experiences or needs. For example, students should re recognize what kind of things the numbers measuring national GNP's, grain productions, average calories per person, percent of GNP spent on education, social programs, or on armaments tell us about national or world problems or their possible solutions. With this kind of integration in subject matter, teachers and students can continue to learn all their lives.

Thank you.

DR. SEABORG: Thank you.

The next speaker will be ---

MR GARDNER: Excuse me, Mr. Chairman. It might interest you to know that two weeks ago the full Commission met in Washington, D.C., and gave the entire day over to studying a comparison and contrasts of the educational system in this country with the educational systems in several advanced industrial countries of the world.

It was not focused only on science and mathematics but cut across all disciplines. I should think that the issues you raised will in the normal course of the hearing -- both of the ones scheduled and of the full Commission -- will give rise to a discussion of those issues.

If not, If it should somehow escape us, then I think we certainly have to consider them.

DR. SEABORG: The next speaker will be Louis Fein.

STATEMENT OF LOUIS FEIN

VISITING SCHOLAR, SCHOOL OF EDUCATION, STANFORD

EXECUTIVE DIRECTOR

PALO ALTO LEARNERS ASSOCIATION

MR. FEIN: Chairman Seaborg, Members of the Commission, my name is Louis Fein. I am this year a visiting scholar at the Stanford School of Education where I am writing a book on the impact of the form of school governance on the quality of education.

My degrees are in physics, but I have worked most of my professional life as a computer scientist. Indeed, 25 years ago as consultant to Stanford University I conceived and named computer science and designed a model university computer science curriculum and research program.

I have been a teacher of mathematics, physics, astronomy and computer science at the secondary and post-secondary levels. I have been Education Committee Chairman of the Association of Computer Machinery: a computer organization.

But I don't come to you today either as physicist or as computer scientist or as teacher. You have heard educators and others make recommendations for what is needed to improve education in mathematics, science, computer science and other fields.

I do come to you today as parent, grandparent and as a citizen representative of a union. Yes, a union! A union whose main interest is to promote and protect the learner's interest, not only in excellence in mathematics, science and computer science education, but in every other aspect of the student's education.

Our union arose out of the recognition that local, state and national teacher legislators they sometimes control, use their governance power to resist and to block some of the kinds of learner-benefitting reforms proposed to you today.

I am executive director of a public school client union in the Palo Alto Unified School District. Families and others in the district with a strong interest in promoting learner's educational interests are eligible to join.

We call our union, founded in 1974, the Palo Alto Learners Association. We have neither a state nor a national learners association yet although we are determined that ours is a forerunner of other local state and national organizations. We believe that only a client union can be depended on to protect the learners interest.

Teachers in our district, of course, are organized into a union to protect and promote their interests, as they should. The local teacher union is called the Palo Alto educators Association whose representative addressed you about an hour or so ago. Their national union is the National Education Association.

We believe and we urge the Commission to consider that an important pre-condition for improving education in the interests of the learner, and therefore of society, is to give learners unions parity with teacher unions as governors of school districts. In collective bargaining these two unions would decide policies on what we call the terms and conditions of learning, as well as the terms and conditions of employment.

That is, they should together decide curriculum, student, teacher and program evaluations; teacher layoffs; tenure, textbooks; salary, inservice training and indeed everything, since everything is involved in the terms and conditions of learning or of employment or both.

We agree with the prevailing view among scholars that education has no clear technology, and that therefore there are no experts in education policy.

As long as that is true, school-client representatives are as capable and certainly as interested, if not more so, than teachers' and administrators' representatives and school board members in making policies aimed at improving education.

We hold that school boards elected by voter-tax payers, voter-parents, voter-teachers, voter-students and supported in their electioneering by such voters and by other local interests (e.s. real estate interests) have obligations to these various interests and therefore can't be expected, even in principle, let alone practice, to represent the learners interest, and therefore the country's interest.

Only a union of learners and their parents can be expected to represent the learners' interests, just as only a union of teachers can be expected to represent the teachers' interest. Our society has legally recognized the latter proposition; I urge the Commission to propose the legal recognition of the former.

We recommend that the Commission accept the idea that client-provider governance is a necessary condition for successfully implementing many of the reforms that are being proposed to you.

Client unions and teacher unions should in a normal collective bargaining procedure negotiate the terms and conditions of learning, the terms and conditions of employment, subject to the veto or approval of a public interest representative.

But the public representative -- the school board-- must not, as it does now, be involved in the negotiations if for no other reason than that the public interest is not negotiable and the public representative should not be permitted to trade off, as it does now, the public interest against negotiable teacher union interests.

Let me just give you one example of what happens when you don't have a client union to protect the learners interest and presuppose that that interest will be protected by others.

In California during the last three years, there has been a coalition among the California Teachers Association, the California Federation of Teachers, the California School Boards Association, the Association of California School Administrators, the PTA, the State Board and the State Department of Education to push the legislation only for more money and to resist any and all reforms of the kind in previous years proposed by the School Boards Association, the Administrators and even the PTA, and of the kind being proposed to your Commission.

If we had local, state and national learners asscoaition with the financial and political muscle of the employee organizations, such successful coalitions to resist reform would be unlikely.

To summarize, as long as there is no organized legally-enabled countervailing force to teacher unions and the legislative and executive bodies they control, reform in education in the learners interest and therefore in the public, interest will be very difficult indeed.

Thank you.

DR. SEABORG: Thank you.

The next speaker is Bob McFarland.

STATEMENT OF BOB MCFARLAND

PRESIDENT, CALIFORNIA MATH COUNCIL

MR. MCFARLAND: I commend the Commission for staying on to hear us out.

I am Bob McFarland. For eight years I was a sixth grade teacher, two years as a school resource specialist, and 12 years as a county math consultant. I am here today as president of the California Math Council which has a membership of 5,000 elementary and secondary teachers of mathematics.

I want to share a cartoon with you which I received in the mail as an editor of a local math newsletter from the NCTM, the National Council of Teachers of Math.

It shows a principal sitting with a teacher, saying to her, "Ms. Perkins, you teach five sessions of English out of a seven-period day. How many unnassigned periods does that leave you?

She says, "Uh, two."

And he gets on the phone and says, "Hello, math department? We have found one to fill your teacher shortage."

(Laughter.)

MR. MCFARLAND: You have heard of math anxiety. But what about the statement, anyone can teach math? I haven't heard that expressed today, but yet I felt it to be fairly prevalent especially in these days of the teacher shortage when teachers are being reassigned to teach math, and even among the elementary teachers, that anyone can teach math.

And I can hold some substance to that, if we are only talking about computational skills. Maybe anyone can teach computational skills, given the right materials.

But I don't believe anyone can teach math if we are trying to teach students problem-solving skills and strategies, logical thinking and reasoning in mathematics.

Good teachers need to know how to ask good questions. They need to know content. They need to know how to be able to respond to good questions from students. They need to be able to encourage good questioning from students.

I don't believe teachers can do this without good inservice programs, especially those teachers who are at the secondary level now being reassigned who may be unqualified or at least not have the background for teaching mathematics.

I have heard many good suggestions for staff development programs today. I certainly support and want to reinforce four suggestions at least for inservice training for teachers.

One would be through membership and support of professional organizations. These organizations that are supported by the membership dues and the time of the members.

Second, through resource centers -- that has been mentioned today -- state resource centers and the federal professional development centers. Third, through courses taught by motivated math educators, not just college studies.

And some college types do tend to be somewhat suspect among other teachers, I have found.

Fourth, through the use of math specialists at, especially, elementary schools. That we don't have much of today. And in fact, we are finding it increasingly so that subject area specialists at the district and the county levels are becoming less and less. Their jobs are being eliminated.

One final note would be that pre-service education certainly needs to receive more emphasis so that we can attract new teachers in the areas of math, science and computer technology.

Thank you.

DR. SEABORG: Thank you.

The next speaker will be Katherine Burt.

STATEMENT OF KATHERINE BURT

KINDERGARTEN TEACHER

MS. BURT: Chairman Seaborg, and Members of the Commission, my name is Katherine Burt. And I thank you for the opportunity for being here because normally I would be among 31 kindergarten children.

I am grateful also to my school district that recognizes the need for teachers to participate in all levels of developing excellence in education.

I wish to make the case for the port of entry -- kindergarten. We do recognize the correlation of math and science and do address this concern.

Inquiry training is vital to be a good teacher of any subject. ESS was my beginning and I thank the people who funded it years ago.

Personally, I encourage hands-on manipulative experiences before the symbolic or abstract level is presented. If the expectations are there, there is a relevant way to teach five year olds pattern recognition, problem-solving, graphing, geometry, estimating, probability and statistics.

Be assured that significant computer experiences are provided kindergarteners in some of our schools. All students next year will receive that training, as the rest of our computers arrive.

Although I recognize money will not resolve all our concerns for the teaching of math and science, I hope such valued resources for students and teachers as the Exploratorium, Lawrence Hall of Science, San Mateo County's Computer Center, will receive continued financial support for their proven efforts.

We cannot leave to chance that these programs will sustain themselves.

As teachers, I feel we have had to reinvent the wheel too many times. It is possible for exemplary programmings to be disseminated by videotape technology.

I encourage you to consider the Foundation for Early Learners, because we have a need for excellence.

Build up on your model. The earliest intervention for the sense of wonder is paramount. It will provide significant results.

I thank you.

DR. SEABORG: Thank you.

The last speaker this afternoon will be Leo Ruth.

STATEMENT OF LEO RUTH

CALIFORNIA ENGINEERING FOUNDATION

MR. RUTH: Thank you, Mr. Chairman and Members of the Commission. I also want to thank the unnamed socalled last speaker who did not show up and thus I have the opportunity to address you. I consider it to be an honor and a pleasure.

My name is Leo Ruth. I am both a civil and mechanical engineer in private practice. I don't know whether to say I am a civil mechanical engineer or a mechanical civil engineer. It depends upon who the potential client might be.

I am the founder and the immediate past president of Ruth and Going, which is an architectural engineering firm in San Jose.

I am not a professional educator in the sense that I am employed by an educational institution. However, I believe that in my office we do a lot of education for potential technicians, technologists and engineers.

Nevertheless, I do have some extracurricular activities. This includes participation in the Accreditation Board for Engineering and Technology, which is the successor to ECPD, the Engineers Council for Professional Development. And I am currently chairman of

Region 7 of the Technology Accreditation Commission of that board.

A second group in which I participate is the California Engineering Foundation and I am a member of the Board of Directors of that foundation.

And it is the organization which I represent today.

CEF is a nonprofit corporation founded in 1974. Its mission is to provide a vehicle for gathering the technical community together to resolve problems in guidance, career development, education and increasing public understanding of engineering, of science, technology and architecture.

There is a special need to increase the science literacy of the general public so as to create a positive public attitude for the development of the technology needed to solve some of the perplexing and complex problems in society.

On November 30 and December 1 of last year, at the Kellogg Center in Pomona, California, the foundation organized and sponsored a two-day conference on "Engineering Education in California: Employer Needs and Constraints."

Significantly, of the more than 100 participants in this conference, the ratio of industry representatives to educators and legislators was three to one. This, to me, indicates the significance that industry recognizes in the industrial-educational complex today.

Four specific areas of concern in engineering education were addressed at this conference:

1. Curricula.
2. Faculty development.
3. Laboratories, technology and applied experience.
4. Administration.

I would like to excerpt some comments from the preface to this conference.

> "The primary objective of the conference on engineering education was to provide educational institutions with the thinking of major industrial employers concerning the type of education technologists and engineers should be receiving.
>
> "Correspondingly, the problems that universities face needed to be illuminated to industry to increase understanding of the current constraints on curricula and faculty development.
>
> "The state and nation face a major challenge that strikes at a way and

quality of life second to none in the world. For the United States to continue its leadership in science and engineering, deal effectively with its national challenges and excell in a highly-competitive world market, proper technological education programs must reflect the realities of the changing environment in engineering and industrial practice.

"However, insufficient attention has been given to the decaying situation in higher education. Many university laboratories have become obsolete and others have fallen into disuse because of changes in curricula.

"In essence, universities have failed to keep pace with the world of changing technology. And the problem is exacerbated by the shortage of funds to update or upgrade laboratory equipment to expose students to new technology."

And I heard that echoed several times this afternoon.

"The salaries for technical faculty are now so far below those being offered in industry that universities can no longer attract or retain the talent needed to properly educate young engineers and scientists.

"In the past, technological and engineering education has been considered strictly the responsibility of educational institutions. It is now apparent that there must be a joint effort between industry, engineering practice and the university.

"There is also a need to communicate the critical requirements of engineering education more effectively to private policy bodies and the general public."

I appreciate the opportunity to present to the Commission a copy of the summary report of the findings and recommendations from this conference. I have given this to your staff representative.

Thank you very much.

DR. SEABORG: Thank you.

The scheduled adjournment time for our hearing is 5:15, and we need to adhere to that in order to get the

Members of the Commission, who made a commitment, to San Francisco this evening.

However, that leaves us five minutes, if someone has an urgent question.

MR. FOSTER: Mr. Chairman, I have one.

DR. SEABORG: All right.

MR. FOSTER: Is Mr. Summerfield here?

MR. SUMMERVILLE: Yes, I am here.

MR. FOSTER: Mr. Summerfield, a question. This Institute for Computer Technology, have you arrived at any initiation fee for entry into this group?

MR. SUMMERVILLE: No, we are offering these programs as part of continuing education in the district. We will be open to students from the member schools.

The evening programs will be available for adults and community members and will undoubtedly be fee-based.

MR. FOSTER: But the industry members are supporting you with funds, and you are looking for more of those, I suppose?

MR. SUMMERVILLE: Yes, we are. Yes, we are. And we are continuing our marketing process to them as we define the first-year curriculum at the start of September. So if we talk specifically to one industry member, we can say, here are our specific needs for our first year of operation, which portion of them would you help us with?

MR. FOSTER: Very good.

MR. SUMMERVILLE: However, the general commitments have been made by all major companies in Santa Clara County.

MR. FOSTER: Very good. Very creative.

MR. SUMMERVILLE: Yes?

MR. GORDON: You spoke of internships for students in the summer so they could work as part of the program.

MR. SUMMERVILLE: Yes.

MR. GORDON: Did you think what would happen with the teachers?

MR. SUMMERVILLE: We are right now in a separate venture in our district, establishing -- and hope to have it in place by the end of this month -- a training facility at least in computer awareness for all of our staff.

We will have a room specifically set aside where we will be able to train our teachers in those areas.

For the other technological areas that we want to offer for teachers, we will have summer programs for them in training in these areas, as well as teaming some of them with members of industry during the actual teaching of our students. So that our students get the benefit of some state of the art technical instruction, at the same time teaming the teacher who has a lot of classroom management educational skills that are very necessary to create the right environment for our students.

MR. GORDON: I am glad to see that you are addressing the need of the teacher to be aware of what is actually happening in industry.

MR. SUMMERVILLE: Thank you, yes we are.

MR. SOMMER: I would like to ask the last speaker -- I forgot the gentleman's name?

DR. SEABORG: Leo Ruth.

MR. SOMMER: Mr. Ruth, how good are our chances to attract more admirable gentlemen like you to support our educational efforts from throughout the private sector?

MR. RUTH: Before I answer the question, I forgot the punchline.

Parenthetically, I was going to say I am disappointed that there were only two industry representatives here today, Bernie Oliver of Hewlett-Packard and Bob Bell of General Electric.

I wish there were an easy answer to your question. My responce from a personal standpoint simply is that I feel that my engineering education and the modicum of success I have in my business, I feel I should plow some of that back into providing better technologists, engineers and scientists to the nation.

The way I originally was appointed to the ECPD accreditation commission was that I happened to be president of the National Council of Engineering Examiners at the time that I went to a meeting of ECPD.

And I said that I was quite upset that all of the accreditation for the engineering programs was done by a commission. It was not done by the user of the product of the school.

Consequently, I was then appointed to the accreditation commission. But I can't give you any answer other than I think you just have to make it exciting.

And I spread the gospel whenever I can.

Thank you.

DR. SEABORG: Thank you.

Well, this brings to an end our public hearing on Science, Mathematics and Technology Education of the National Commission on Excellence in Education, the first of six public hearings that are going to be held.

I think this has set a good example and, Jay Sommer, I think you will have something to live up to in your hearing in Houston.

On behalf of the Commission Members, I want to thank the 28 speakers this afternoon for their interesting and instructive talks. And I would like particularly to thank the members of the audience who have supported us by their attendance here, which heartens us very much in our task.

So with this, we come to the end of our first hearing.

Thank you very much.

(Whereupon, at 5:15 p.m., the Public Hearing on Science, Mathematics and Technology Education of the National Commission on Excellence in Education was concluded.)

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C E R T I F I C A T E

I hereby certify that this is the transcript of the Public Hearing on Science, Mathematics and Technology of the National Commission on Excellence in Education held on Thursday, March 11, 1982, and that this is a full and correct transcript of the proceedings.

Frances L. Rhudy

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